THIRD QUARTER 1958
Vol. 4, No. 3

# ENVIRONMENTAL QUARTERLY

*prescription for a successful orbit*
**"SHAKE WELL BEFORE USING"**

## Ling vibration testing proves reliability of Explorer satellites before launching

THE SUCCESS STORY of the Explorer Satellites actually began long before the countdown. Every piece and component was vibration "flown" again and again through endless testing and checkout procedures.

In fact, the *fully assembled* Explorer Satellites now in orbit were given a thorough vibration testing at Caltech's Jet Propulsion Laboratory in Pasadena, California.

The actual conditions of space flight were computed in a synthesized program, and, using Ling Electronic power generators and advanced techniques, space flight conditions were duplicated in the laboratory!

The ability to develop complex test equipment for new and challenging areas such as this is one of the reasons Ling is recognized as a leader in high power electronics.

(See Page 2 for technical test data)

LING ELECTRONICS INC.

9937 West Jefferson Blvd., Culver City, California
Telephone: TExas 0-7711

Jul 28 '58

Beach-Russ
Vacuum Pumps
get your
equipment to
higher altitude
conditions
FASTER
The correct type and size vacuum pump for your specific needs available from the Beach-Russ line of more than 30 single-and two-stage vacuum pump models.
Our experienced engineering department extends an offer of technical help in your chamber development program. All requests should be directed to Beach-Russ Company, Dept. 47.
Write Dept. 47 for Literature
Beach-Russ Company
50 CHURCH STREET • NEW YORK 7, N. Y.

Vol. 4, No. 3 Third Quarter 1958

# ENVIRONMENTAL QUARTERLY

*Official Publication of the Environmental Equipment Institute and the Institute of Environmental Engineers*

**Editor**
RAY H. MATTINGLEY

*Artist*
*Kate Long Hill*

**Executive Committee of the IEE**

GEORGE D. WILKINSON, *Gen. Mgr.*
ROGER J. AMOROSI, *President*
HAROLD C. JONES, *Executive Vice President*
ARTHUR B. BILLET, *Vice President, Fiscal Affairs*
ROBERT L. STALLARD, *Vice President, Publications*
BERNARD FRIEDMAN, *Vice President, Local Chapters*
STEPHEN D. DANKO, *Vice President, Membership*
HENRY F. SANDER, *Ex-Officio Member*

**Executive Committee of the EEI**

GEORGE D. WILKINSON, *Gen. Mgr.*
R. J. JACOBSON, *President*
CHARLES C. E. HARRIS, *Executive Vice President*
JACK SHAMROTH, *Member*
NICK MILLER, *Member*
MONROE SELIGMAN, *Member*
E. S. BROWN, *Ex Officio Member*

**MFG MEMBERS OF THE EEI:**

**Alpha Electric Refrigeration Co.**
**American Research Corporation**
**Bemco, Inc.**
**Blue M Electric Co.**
**Cincinnati Sub-Zero Products**
**Harris Refrigeration Company**
**Hudson Bay Co., Div. of Labline, Inc.**
**international Radiant Corp.**
**Murphy & Miller, Inc.**
**Standard Cabinet Company**
**Tenney Engineering, Inc.**

**ASSOC. MEMBERS OF THE EEI:**
**Minneapolis-Honeywell Regulator Co.**
**Dean Products, Inc.**
**The Bristol Company**

Copyright © 1958, the Environmental Equipment Institute, Inc., and the Institute of Environmental Engineers, Inc. Published four times a year. DR. GEORGE D. WILKINSON, Gen. Mgr. U. S. and Canada, $4.00 per year. Other countries, $5.00. $1.00 per copy, when available. Offices: **9 Spring St., Princeton, N. J. WAlnut 1-6850.** Statements and opinions appearing in the **Environmental Quarterly** are individual expressions and are not necessarily those of the Staff of the Quarterly nor of the EEI or the IEE. Printed by Princeton Printing Co., Princeton, N. J.

**B. T. Accelerometer Response Under Environmental Extremes** 4

by Aleck Goldberg, Frankford Arsenal

*Mr. Goldberg reports on a sensitivity study of several models of B. T. accelerometers.*

**Rough Road and Railroad Humping Specification Testing** 10

by Edward J. Kirchman, The Martin Company (Baltimore)

*Here is a wealth of concrete test data on a subject not very well covered in existing literature.*

**Heat Transfer Between Vibration Exciters and Environmental Chambers** 20

by Wayne Tustin, MB Mfg. Co., and Arthur Schwartz, Atlas Engineering Corp.

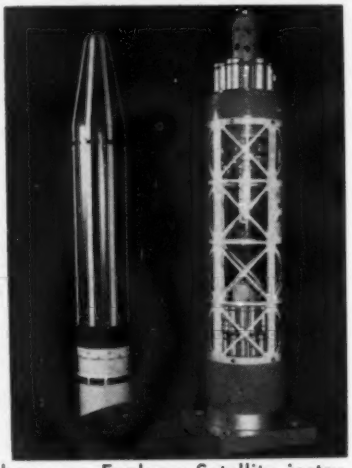
**Pres. Amorosi Calls IEE Second Annual Meeting Success** 27

**New Officers of EEI and EEI Annual Meeting** 17

**Rudkin of Arma Wins Plaque Again for IEE N. Y. Chapter** 22

**IEE Local Chapter News** • 2
**Developments** • 8
**New IEE Members** • 23
**Professional Cards** • 19

**Shake Well Before Using**



This close-up shows an Explorer Satellite instrunentation package on the shaker table prior to testing. Because of the conditions encountered in the flight to space, a random wave program was the only vibration test considered realistic enough for the Explorers.

Tests at JPL included random noise band limited to 20-1500 cps with an amplitude as great as 25 G rms perpendicular to the thrust axis.

**LING ELECTRONICS, INC.**

. . . leader in vibration test systems

**RELIABILITY SUPERVISORS**

***Components and Systems***

***To $12,000 per year***

***Experienced in complex environmental testing and reliability studies on systems and components. Supervisory ability required. B. S. degree in Electrical Engineering. East coast—Midwest—West coast locations.***

**Call or Write**

**Don Moss**

CADILLAC ASSOCIATES, INC.

**220 S. State St., Chicago 4, Ill.**

**WAbash 2-4800**

# IEE LOCAL CHAPTER NEWS

### New Chapter Being Formed at Dayton, Ohio

DAYTON—Don Fox, of the Barrymount, Corporation, has formed a steering committee for the formation of a Local Chapter in this area. The Steering Committee, chaired by Fox, held its initial meeting June 4th and organized itself as follows: *Chairman*—Fox; *Vice-Chairman*—John Cahill; *Publicity*—Dale Towers; *Membership*—Neal Grannick, and Herb Crafton; *Secretary*—R. E. Van Patten; *Treasurer*—Jack Schoenberger; and *Program*—D. C. Kennard, Frank Carothers, and Earl Haber.

The Steering Committee plans several meetings during the summer with the kick-off general chapter formation meeting scheduled for September 11. The group intends to hold occasional meetings in Columbus, Cincinnati, Indianapolis, and other cities.

CHICAGO—The Chicago Chapter listened to a talk on "Why Metals Fail" at its late spring dinner meeting. The speaker was Robert Dallman, Chief Metallurgist of the Robert W. Hunt Co., Chicago. The well-attended session also saw two U. S. Navy movies: "Environmental Factors in Reliability" and "Design for Vibration." The meeting place was in the quarters of the Western Society of Engineers at 84 East Randolph Street.

BALTIMORE—Nearly half a hundred members and guests attended the latest meeting of the Mid-Atlantic Chapter, according to Martin Schletter, Chapter Secretary. The meeting was held at the Westinghouse Air Arm plant near Baltimore, and James E. Allen, Supervisor of Environmental Engineers at Westinghouse Air Arm, gave a talk on "Effective Management of Environmental Laboratories." The group also toured the main environmental facilities of both the engineering div. and the manufacturing div. of Westinghouse.

David Askin, Chapter Chairman, announced election results for 1958-59 as follows: OFFICERS: *Chairman*—Askin, Pitman-Dunn Laboratory, Frankford Arsenal; *Vice-Chairman*—Harold C. Jones, Westinghouse Air Arm; *Secretary*—Schletter, Tenney Engineering, Inc.; *Treasurer*—Stuart G. Hibben, Westinghouse Air Arm; and *National Director*—Peter J. Zukauskas, The Martin Company (Baltimore). CHAPTER DIRECTORS: Ted Foti, The Martin Company (Baltimore); Dan Grady, General Electric (Philadelphia); Fred M. Reitz, Emerson Research Laboratories; and Zukauskas.

NEW YORK CITY—At the June meeting of the New York Metropolitan Chapter, some sixty-five members and guests heard Alfred N. Block of the U.S. Army Chemical Center discuss the pros and cons of the validity of environmental simulation as compared with effects from natural environments. Ralph Ferry, Chapter Secretary, introduced the incoming Chapter President, John Sexton. Sexton announced the results of the Chapter election as follows: *President*—Sexton, Arma Div., American Bosch Arma Corp.; *Vice-President*—John T. Muller, Consultant to Sperry Gyroscope and Convair (San Diego), *National Director*—John Cammarata, Arma Div., American Bosch Arma Corp.; *Secretary-Treasurer—Ferry*, Allied Control Company; *Membership Chairman*: Robert Rudkin, Arma Div., American Bosch Arma Corp.; and *Publicity Chairman*—Socrates Vavoudis, General Precision Labs.; *Chapter Directors*: Brad Rosenthal, Ford Instrument Co., and J. Robert Tucker, U. S. Testing Co.

### Los Angeles Group Extremely Active

LOS ANGELES—Under the vigorous leadership of Irving P. Polak, Marquardt Aircraft Co., Bruno J. Forsher, Hughes Aircraft Company, Jack Mason, Marquardt Aircraft Co., Frank D. Schwark, Rocketdyne, and others, the Proposed Los Angeles Chapter is

*(Continued on Page 9)*

THE NEW GENISCO

# ANGULAR OSCILLATING TABLE

**Generates a precise sinusoidal function accurate to within 0.1% at excursions up to ±2°, 0.5% up to ±10°, and 1% up to ±15°.**

This newest Genisco machine utilizes a unique conical crank mechanism to generate an angular oscillation which closely corresponds to a theoretical sinusoidal waveform. A precision sine-cosine resolver coupled to the crankshaft can be used to bring a test instrument output signal and the oscillating table output signal into coincidence for direct reading of phase lag angle.

The extreme accuracy of the Model B386 Oscillating Table makes it particularly suited for evaluating the damping and response characteristics of angular accelerometers and rate gyros. The Model B386 can also be used for calibrating peak angular velocities and peak accelerations to the accuracy of the known angular excursion and frequency. Within its range, the machine can double as an environmental angular shake table.

For complete information and performance specifications, write to–

*Brief specifications*

**Angular Excursion:** Infinitely adjustable from zero to ±15°.

**Frequency Range:** Continuously variable from 0.02 to 3 cps in the low range; 0.2 to 30 cps in the high range.

**Accuracy:**
Angular Excursion – within 10 minutes of arc.
Frequency Indication – within 1% with tachometer; within 0.1% with stroboscope.

**Payload Capacity:** 100 lb. deadweight, 750 lb.-in. under dynamic conditions. Protected against dynamic overload by replaceable shear pins.

**Vibration Isolation:**
Vertical Displacement – 0.003" max. at any frequency
Lateral Displacement – 0.001" max. at any frequency.

**Platform Diameter:** 8".

**Approx. Weight:** 400 lb.

Genisco INCORPORATED

2233 FEDERAL AVE., LOS ANGELES 64, CALIFORNIA

# B. T. Accelerometer Response Under Environmental Extremes

ALECK GOLDBERG, Frankford Arsenal

**Mr. Goldberg does shock and vibration research and development at the Army's Pitman-Dunn Laboratories, Frankford Arsenal. Here he reports on an impartial study of barium titanate accelerometers.**

WHERE VIBRATIONAL parameters are being monitored in the laboratory with barium titanate accelerometers under combined environment conditions, the accelerometers themselves are subject to the same forces that act on the items under test.

Thus there is a need for sensitivity evaluation of accelerometers if these transducers are to furnish reliable data.

Because of this need, we in the Environmental Testing Branch of Pitman-Dunn Laboratories have carried out a sensitivity study of several models of B. T. accelerometers under the following conditions:

a. Steady state sensitivity evaluation on the MBC-31 Vibration shaker through a frequency range of 50 to 500 cycles per second conducted at low, high, and room temperatures.

b. Ascertaining the effect of shock tests on accelerometer sensitivity with the sensitive axis and connector at right angles to the direction of shock. The Barry Shock machine was used to produce six shocks of a magnitude

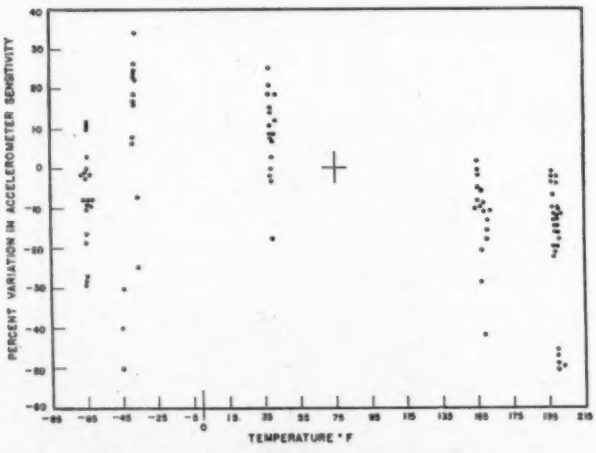



**Figure 1. Sensitivity variation (with respect to room temperature) of total number of accelerometers tested.**

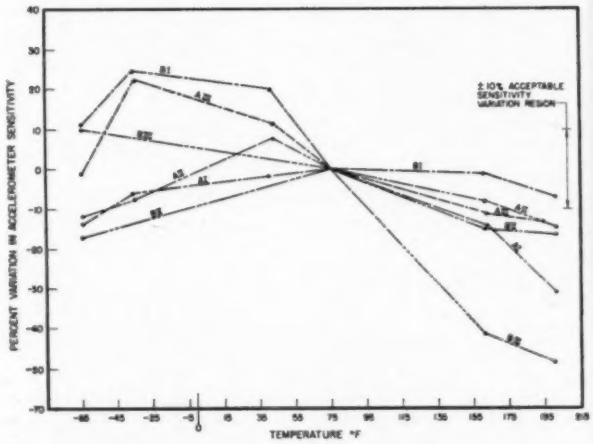



**Figure 2. Arithmetic average of sentitivity variations of given accelerometer models as a function of temperature.**

of 30 G acceleration and time duration of eleven milliseconds.

c. Determination of accelerometer response in an acoustic noise environment of 125 to 135 DB of field intensity by use of a special laboratory-designed acoustic chamber.

d. Subjection of accelerometers type B-I to exposure to 4 (± 1) inches per hour of rainfall environment in accordance with MIL-E-5272A, paragraph 4.10, and subjection to a salt spray test of 50 hours in accordance with MIL-E-5272A, paragraph 4.6.

### Results of Study

The results of our study, expressed here in tabular form (see Tables 1, 2, 3, and 4), represents a summary of accelerometer sensitivity and percent of sensitivity variation for a particular temperature environment and response for a particular acoustic noise field.

In general, our study points strongly to a need for carrying out sensitivity evaluations of B. T. accelerometers in the particular environments under which they

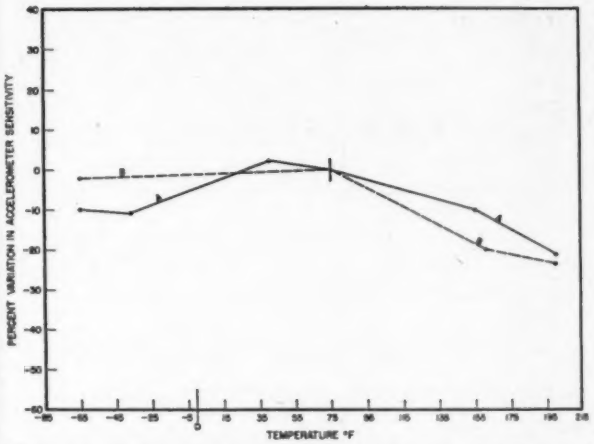



**Figure 3. Arithmetic average of sensitivity variations of types "A" and "B" as a function of temperature.**

are to be used.

The scatter diagram in Figure 1 represents the results of the individual tests. For a given temperature, Figure 1 shows the percent variation of individual accelerometer sensitivity from the cluster of points representing more or less the mean sensitivity variation.

Figure 2 represents the arithmetic average of sensitivity variations of the accelerometers representing a given model. This method of data presentation supplements the scatter diagram (if there are enough cases to yield realistic averages) since it more clearly indicates sensitivity variation trends. Arbitrarily, in this graph, we set up a ± 10% sensitivity variation region as being acceptable. Most accelerometer manufacturers state in their literature that the transducer will not vary in sensitivity more than ± 10% within temperature spans of from -65° to + 200°F. In short, from Figure 2, we observe for a given model the temperature at which it is unsafe to assume the existence of the ± 10% sensitivity variation region. This indicates the need for calibration of the accelerometers at those temperatures in which sensitivity variations are outside the ± 10% region.

**MR. GOLDBERG has engaged in shock and vibration research and development at Frankford Arsenal's Pitman-Dunn Labs since 1951. He holds two degrees in physics from Temple University — BA 1946 and MA 1948. He has been teaching math at Spring Garden Institute in Philadelphia since 1951. Author of nearly a dozen R & D reports published by Frankford Arsenal, and is presently investigating all aspects of random motion vibration.**

Figure 3 represents the arithmetic average of sensitivity variations for all accelerometers representing type B. The scarcity of data is evident in representing a realistic average curve. However, on the whole it can be seen that for low temperature work (-65°F.) the sensitivity variations do fall into the acceptable ± 10% region. On the high temperature range, we encounter the unacceptable sensitivity variation region at +117°F for Type B and at +155°F for Type A. Of course, if greater accuracy than ± 10% is desired, it may be observed from these curves within what temperature range the desired accuracy can be obtained.

### Noise Test

The response of the accelerometers studied when exposed to an acoustic noise field of 125 to 135 decibels was from four to eleven G of acceleration, with the exception of Accelerometer A-II-4, the response of which

*(Continued on Next Page)*

**TABLE I**
**Results of Sensitivity Study on B. T. Accelerometers, Type A.**
Note: Percent in right part of cols. II through VI show variation with respect to sensitivity determined at room temp.

| | I | II | | III | | IV | | V | | VI | | VII | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Accelerometer Identification | Room Temperature Sensitivity | +160°F. Temperature Sensitivity | | 200°F. Temperature Sensitivity | | +40°F. Temperature Sensitivity | | -35°F. Temperature Sensitivity | | -65°F. Temperature Sensitivity | | Response to Acoustic Field | | | |
| | (mv/G) | (mv/G) | (%) | (mv/G) | (%) | (mv/G) | (%) | (mv/G) | (%) | (mv/G) | (%) | (DB) | (cps) | (mv-Rms) | (G) |
| Type A Model II | | | | | | | | | | | | | | | |
| A-II-1 | 1.12 | 1.02 | -9 | 1.01 | -10 | — | — | — | — | 1.10 | -2 | 126 | 725 | 5.8 | 7 |
| A-II-2 | 1.23 | .98 | -20 | .97 | -21 | — | — | — | — | 1.04 | -15 | 134 | 108 | 6 | 7 |
| A-II-3 | 1.16 | 1.08 | -7 | 1.02 | -12 | — | — | — | — | .85 | -27 | 130 | 600 | 5 | 6 |
| A-II-4 | 1.25 | 1.12 | -10 | 1.07 | -14 | — | — | — | — | 1.23 | -1 | 136 | 1080 | 18 | 20 |
| A-II-5 | .96 | .88 | -8 | .76 | -21 | 1.06 | +10 | 1.20 | +25 | .89 | -7 | — | — | — | — |
| A-II-6 | .83 | .76 | -8 | .69 | -17 | .90 | +8 | 1.01 | +22 | .77 | -7 | — | — | — | — |
| A-II-7 | .96 | .88 | -8 | .85 | -11 | 1.09 | +14 | 1.01 | +5 | .95 | -10 | — | — | — | — |
| A-II-8 | .92 | .83 | -9 | .75 | -18 | .92 | 0 | .69 | -25 | .65 | -29 | — | — | — | — |
| A-II-9 | 1.20 | 1.14 | -5 | .96 | -20 | 1.27 | +6 | 1.38 | +15 | 1.20 | 0 | — | — | — | — |
| A-II-10 | 1.06 | .98 | -8 | .87 | -18 | 1.15 | +8 | 1.23 | +16 | .95 | -10 | — | — | — | — |
| A-II-11 | 1.0 | 1.02 | +2 | .97 | -3 | 1.03 | +3 | 1.07 | +7 | .93 | -7 | — | — | — | — |
| Type A Model III | | | | | | | | | | | | | | | |
| A-III-1 | 1.16 | .95 | -18 | .98 | -15 | — | — | — | — | 1.21 | +4 | 132 | 1000 | 7 | 8.5 |
| A-III-2 | .80 | .75 | -6 | .70 | -13 | .89 | +11 | .98 | +22 | .74 | -8 | — | — | — | — |

**TABLE II**
**This is a continuation of Table I.**

| | I | II | | III | | IV | | V | | VI | | VII | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Accelerometer Identification | Room Temperature Sensitivity | +160°F. Temperature Sensitivity | | 200°F. Temperature Sensitivity | | +40°F. Temperature Sensitivity | | -35°F. Temperature Sensitivity | | -65°F. Temperature Sensitivity | | Response to Acoustic Field | | | |
| | (mv/G) | (mv/G) | (%) | (mv/G) | (%) | (mv/G) | (%) | (mv/G) | (%) | (mv/G) | (%) | (DB) | (cps) | (mv-Rms) | (G) |
| Type A Model I | | | | | | | | | | | | | | | |
| A-I-1 | 7.33 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A-I-2 | 8.16 | --- | --- | 4.20 | -49 | 7.73 | -5 | --- | --- | --- | --- | --- | --- | --- | --- |
| A-I-3 | 8.08 | --- | --- | 4.41 | -46 | 6.73 | -17 | --- | --- | --- | --- | --- | --- | --- | --- |
| A-I-4 | 6.45 | --- | --- | 3.64 | -44 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A-I-5 | 9.00 | --- | --- | 4.65 | -48 | 8.83 | -2 | --- | --- | --- | --- | --- | --- | --- | --- |
| A-I-6 | 8.24 | --- | --- | --- | --- | 8.98 | +9 | --- | --- | --- | --- | --- | --- | --- | --- |
| A-I-7 | 5.83 | 5.15 | -12 | 4.91 | -16 | --- | --- | --- | --- | 5.79 | -1 | 125 | 740 | 23 | 6 |
| A-I-8 | 4.77 | 4.32 | -9 | 4.45 | -7 | --- | --- | --- | --- | 3.54 | -26 | 127 | 720 | 28 | 9 |
| A-I-9 | 3.00 | 2.20 | -27 | 2.60 | -13 | 2.84 | -5 | 2.78 | -7 | 2.74 | -9 | --- | --- | --- | --- |

**TABLE III**
**Results of Sensitivity Study on B. T. Accelerometers, Type B.**

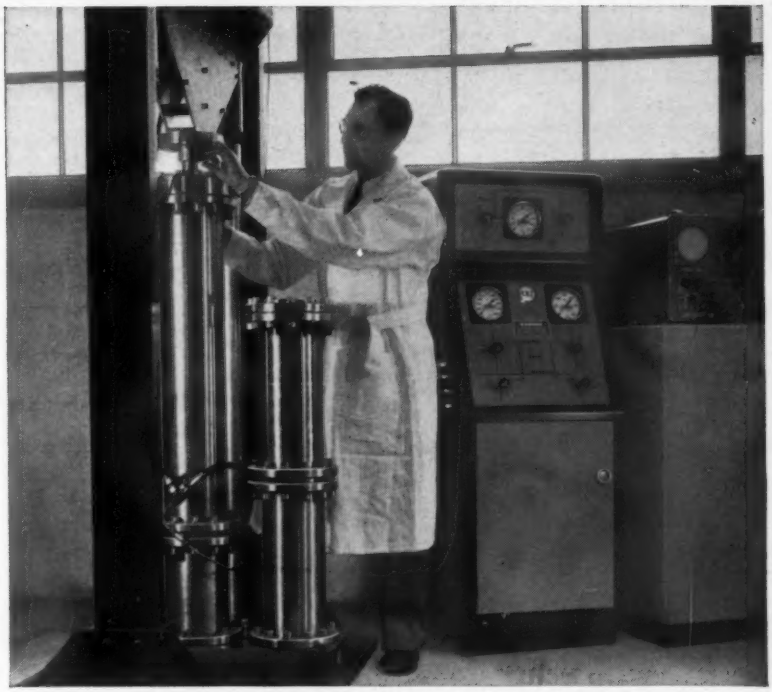
| | I | II | | III | | IV | | V | | VI | | VII | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Accelerometer Identification | Room Temperature Sensitivity | +160°F. Temperature Sensitivity | | 200°F. Temperature Sensitivity | | +40°F. Temperature Sensitivity | | -35°F. Temperature Sensitivity | | -65°F. Temperature Sensitivity | | Response to Acoustic Field | | | |
| | (mv/G) | (mv/G) | (%) | (mv/G) | (%) | (mv/G) | (%) | (mv/G) | (%) | (mv/G) | (%) | (DB) | (cps) | (mv-Rms) | (G) |
| Type B Model I | | | | | | | | | | | | | | | |
| B-I-1 | 11.2 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| B-I-2 | 13.7 | --- | --- | 13.3 | -3 | 17.0 | +19 | 17.9 | +24 | --- | --- | --- | --- | --- | --- |
| B-I-3 | 11.5 | --- | --- | 10.4 | -10 | 14.4 | +25 | 14.6 | +27 | --- | --- | --- | --- | --- | --- |
| B-I-4 | 17.0 | --- | --- | 16.3 | -4 | 20.5 | +21 | 20.2 | +19 | --- | --- | --- | --- | --- | --- |
| B-I-5 | 13.2 | --- | --- | 11.8 | -12 | 15.7 | +19 | 17.8 | +35 | --- | --- | --- | --- | --- | --- |
| B-I-6 | 12.1 | --- | --- | --- | --- | 13.8 | +14 | 14.8 | +22 | --- | --- | --- | --- | --- | --- |
| B-I-7 | 19.1 | 18.8 | -1 | 18.7 | -1 | --- | --- | --- | --- | 21.2 | +11 | 129 | 640 | 56 | 4 |
| B-I-8 | 18.1 | 18.1 | 0 | 17.6 | -3 | --- | --- | --- | --- | 20.5 | +13 | 133 | 1000 | 98 | 7.3 |
| Type B Model II | | | | | | | | | | | | | | | |
| B-II-1 | 11.9 | 10.1 | -15 | 10.0 | -16 | --- | --- | --- | --- | 9.9 | -17 | 125 | 740 | 93 | 11 |
| Type B Model III | | | | | | | | | | | | | | | |
| B-III-1 | 16.3 | 9.5 | -42 | 8.3 | -49 | --- | --- | --- | --- | 17.9 | +10 | 128 | 680 | 78 | 7 |

was 20 G. However, if vibration or shock data were being monitored in an acoustic noise environment of 125 to 135 decibels of sound intensity, the transducers would not differentiate in their response between vibration and shock environments and acoustic noise environments. Just how much of the accelerometer response is vibration or shock acceleration and how much is response to acoustic noise will depend on the interaction of the two effects, their phase relationship, frequency content, and amplitudes.

In other words, it is difficult to predict, *a priori,* how much of a measurement is vibration or shock and how much is due to noise since the accelerometer will not differentiate the cause. To ascertain quantitatively the accelerometer response to acoustic noise fields present in a vibration or shock environment, we must perform laboratory tests where vibration and shock measurements are first made in a relatively noiseless acoustic field and then in the presence of a known acoustic noise field. Nevertheless, the fact that as much as 20 G of acceleration response is obtained could be of considerable significence in the measurement of small shocks or vibrations in a high acoustic noise field.

*(Continued on Page 18)*

**You can produce predictable, repeatable acceleration-shock thrusts to 40,000 lbf. with Hyge**



Hyge shock tester takes about 60 seconds to complete acceleration-shock test with up to 40,000 lbf. thrust. Hughes Products Memoscope® oscilloscope retains wave pattern as long as you like for careful study and comparison with master pattern.

# High-g thrusts you can trust for controlled shock tests

Hyge gives you an amazingly simple way to simulate actual service conditions for shock testing small and large assemblies.

Hyge gives you complete control over all variables. It ends the guesswork inherent in such devices as air cannons, impact hammers, and drop towers.

With Hyge you can accelerate a specimen to several hundred g's in just milliseconds with exact reproduction of preset half-sine, square, and sawtooth patterns.

### How it works

Hyge is a piston in a cylinder which is divided by an orifice plate. Using nitrogen, you build up a small pressure against the top of the piston, sealing it to the orifice plate. You can then build up a very large pressure against the bottom of the piston, since you are working against only the small area exposed by the orifice. As soon as the pressure against the bottom overbalances the top pressure, the seal breaks and the whole piston bottom is exposed to the larger pressure. The piston is then thrust upwards at a tremendous speed.

Hyge transmits this thrust directly through a column to a test platform which rides on deceleration rails. Preselected metering pins control the thrust pattern, make it infinitely repeatable.

### Free bulletin

Bulletin 4-70 gives you much more information on the theory and application of Hyge, including specifications and accessories for the HY-6000 Hyge and the smaller, 10,000 lbf. Hy-3000.

**Consolidated Electrodynamics**

**Rochester Division, Rochester 3, N. Y.**

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

# developments

Proposed Los Angeles Chapter of the IEE has been carrying out a series of "summit" type meetings with officers of the Society of Environmental Engineers in California toward the consideration of possible merging of forces. At press time for this issue, the negotiations were still in process, according to Bruno J. Forsher, Hughes Aircraft Company, and one of the leaders of the Los Angeles Chapter Steering Committee.

•

Saul S. Schiffman has been named Chairman of the Board of Tenney Engineering, Inc., Union, N. J. Tenney, manufacturer of environmetal test chambers, is a manufacturing member of the Environmental Equipment Institute. Tenney stock is now traded over-the-counter. Schiffman is continuing as Secretary-Treasurer and Chief Financial Officer of the Company, a post he has held since 1945.

•

The *Environmental Quarterly* is to carry a "Professional Card" department, commencing with this issue. Laboratories, consultants, and others are cordially invited to write the magazine at 9 Spring St., Princeton, N. J., for details.

•

Bernard Friedman has announced his assumption of duties as General Manager-Technical Director at International Radiant Corporation, Westbury, N. Y. Friedman is also Vice President for Local Chapters of the Institute of Environmental Engineers.

•

Blue M. Electric Company has recently been accepted as a manufacturing Member of the Environmental Equipment Institute. Blue M's new Catalog 158 cover's the company's complete line of environmental chambers, ovens, furnaces, baths, related temperature control equipment, accessories, etc. 138th & Chatham St., Blue Island, Ill.


**THERMOSEAL**

**Viewing glass units for environmental chambers. Tolerates −100° F to +350° F differential. Prompt deliveries; engineering service available. Write to**

**THERMOSEAL GLASS CORPORATION**
**P. O. Box 342**
**Camden 1, N. J.**

**ANY SIZE**
**TEST EQUIPMENT**

From one of the largest pre-packaged factory tested Walk-in Altitude rooms ever installed in a vendor's plant (Illus. above) to small portable chambers, American Research Corp. engineers and builds a complete range of pre-tested and packaged installations for testing under a wide variety of environmental conditions. Altitudes to 200,000′ and higher, temperatures from −100° F to +500° F, internal vibration available at all temperatures and altitudes.

Write for complete new catalog.

AR

AMERICAN RESEARCH CORPORATION
FARMINGTON 3, CONNECTICUT

## LOCAL CHAPTER NEWS

(*Continued from page 2*)

carrying out a closely-spaced series of well-planned meetings and other events.

The Chapter organization meeting is scheduled for July 24, following the completion of negotiations with the Society of Environmental Engineers for a possible merger.

According to Forsher, the Los Angeles Chapter Steering Committee met with the officers of the S. E. E. to discuss possibility of the S. E. E.'s integration with the National IEE. Forsher stated that one of the primary questions remaining to be answered by the membership of S.E.E. was whether or not that group desired to remain a local society to extend its range and influence into National scope. This point will have been resolved too late for coverage in this issue of the *Environmental Quarterly*.

On April 9, the Los Angeles group heard Wilson Bradley, General Manager of Endevco Corporation, who described Endevco's pioneer work in the application piezo-electric transducers. Bradley stressed two points of importance for reliable measurement of vibration. *First*: Natural frequency of the transducer should be a minimum of 5 times the highest frequency to be generated or measured. *Second*: Control over the wave purity (sine wave) is imperative for correct indication of "g" values measured by the piezo-electric transducer. Application of the transducer in a temperature range of minus 65° to plus 500° with better than plus or minus five percent accuracy was shown in the motion picture "Vibration and its Measurement."

At the May 9 meeting, Jack Mason, of Marquardt, reported on the Second Annual Meeting of the IEE held in New York City April 17-18. He stated that he thought the meeting had been unusually well-organized and that the papers maintained consistantly high intellectual and technical standards. He also praised the fact that the Armed Services were well represented. He indicated that he had talked with Dr. George D. Wilkinson, IEE General Manager, and that Dr. Wilkinson had indicated great interest in offering special considerations to the officers and members of S.E.E. in connection with a possible merger.

The "Inhabited Space" Research Lab of Litton Industries provided a fascinating focus for the June 17 meeting. The Director of Litton's general Research Lab, Herbert Reich, was official guide and commentator for the look at this extreme high vacuum walk-in chamber, which is capable of holding a vacuum equivalent to 95 miles altitude. A major portion of the research being carried out here, Reich said, is devoted to the developmnt of a practical space suit that may one day be worn by space navigators. The first model of such a space suit developed at Litton weighs 50 lbs and maintains a pressure of 5 psi (absolute) of oxygen for its occupant.

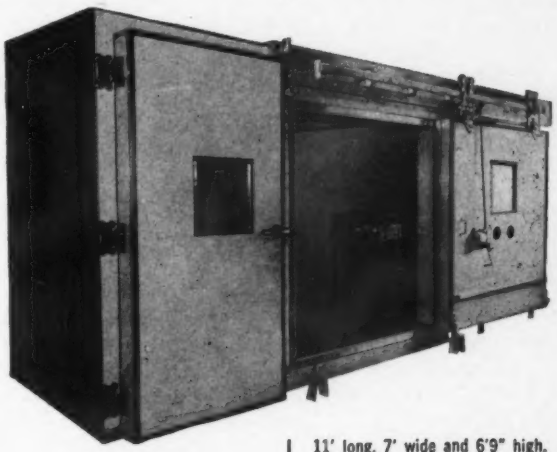
Among the experiments shown to demonstrate the effects of space environment, the most striking one was the comparison of a free fall between a feather and a steel ball. Both fall with the same velocity inside space simulated environment. Of particular significance for missile and space craft development, however, is the experiment which proves that lack of *air film* eliminates normal slide action. A metal piece, which under sea level condition will slide freely down an inclined plane will fail to do so in vacuum, even if the angle of the slide is increased to nearly vertical. This phenomenon, Reich pointed out, should warrant careful studies for all mechanical equipment of space craft or missiles to be located outside pressurized compartments.

### REMINDER

### EEI Annual $100 Awards for Best Articles

Some time ago the EEI announced establishment of two annual $100 awards for best articles appearing in Environmental Quarterly. One of the two must have first been presented at a local chapter meeting of the IEE. First contest is for the calendar year of 1958.


today's testing... | tomorrow's product...



ENVIRONMENTAL WALK-IN CHAMBER

11' long, 7' wide and 6'9" high, with 6'6" door opening. Temperature range −90° to +250°F. For Humidity Cycling, Rain Tests, Freezing Rain, Sand and Dust Tests, etc.

■Whether it's for chemical, technical or engineering tests...whether it's for the very smallest commercial electronic component to the very largest military missile...you'll find the experienced research department and staff *you* want at New York Testing Labs. You'll find all the facilities needed to carry out Certified Qualification Tests (to all phases of MIL E 5272A), and you'll find complete chemical, engineering and research laboratories geared to make the most accurate tests and evaluations ever offered under one roof! For over 40 years, New York Testing Laboratories, Inc. has set a standard for accuracy and quality...why not find out more today?

■**Write or call for more information about our vast facilities. There's no obligation, of course.**

**NEW YORK**
**TESTING LABORATORIES, INC.**

47-48 WEST STREET, NEW YORK 6, N.Y.
BOWLING GREEN 9-6220

*Literature on the subject of induced severity of accelerations in railroad humping and rough-road tests is in short supply. This article affords a wealth of concrete test results.*

# *Rough Road and Railroad Humping Spec. Testing*

EDWARD J. KIRCHMAN, The Martin Company

RECENT MIL specifications covering ground-handling systems for electronic equipment call out railroad humping and rough road tests. A series of such tests have been performed by The Martin Company with the cooperation of the U. S. Army Transportation Corps at the Aberdeen Proving Grounds.

A conventional trailer with rack-mounted equipment was tested by being humped at 4, 6, 8 and 10 miles per hour into one and three railroad cars. In addition, there were five traverses over each of the following sections of the Munson rough-road course:

| Road Type | Speed |
|---|---|
| Coarse washboard, 6-inch waves, 72-inch apart | 5 mph |
| Belgian block | 20 mph |
| Radial washboard, 2- to 4-inch waves | 15 mph |
| Single corrugations, 4- to 6-inch sections | 20 mph |
| Short sections linking the above | 20 mph |

Accelerometers used were: Statham with a frequency response of 0 to 1,200 cps; Martin with 0 to 25 cps; and Gulton with 3 to 3,000 cps. Data were recorded by Consolidated oscillograph. The galvanometer limited the responses of the system.

Installation of the trailer on a flatcar for the humping tests (Fig. 1) conforms with railroad loading standards. The rear axle was chocked to take up the load of the tires, bracing was applied fore and aft, and appropriate guy wires were rigged.

### Humping Tests

Humping followed this procedure. Pushed by a Diesel switching engine at specified speed, the test car was released at a point about 50 feet from the stationary cars and allowed to coast into them. Both a single gondola loaded to about 20,000 pounds and a series of three empty cars were used as the stationary cars.

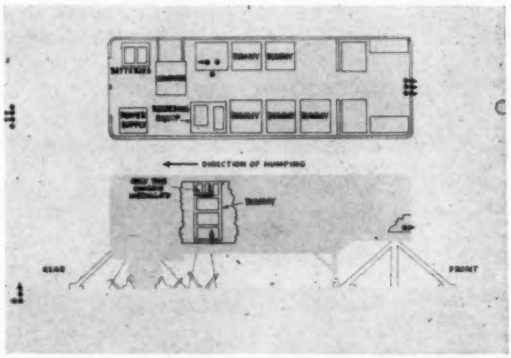



**Figure 1. Accelerometer locations in humping test.**

Speed was recorded from an automobile, with a calibrated speedometer, which paced the switch engine. For a more accurate speed measurement, a stopwatch was operated between explosions of two railroad caps set at the 50-foot release point and just before contact.

The first test was performed at 4 mph into the single gondola with no apparent damage. At 5.2 mph, the tie down wires loosened. At 7.4 mph the rear drag brace failed and there was further wire loosening. With the tests repeated into three cars, the drag brace again failed at 5.2 mph and was removed. At 7.9 mph the tie wires loosened and the chocks collapsed. Chocks of the contoured type were substituted and heavier bracing installed. In the final run — into a single gondola at 11.4 mph — the forward post was split during rebound and all wires loosened severely.

Humping test results are shown in Figure 3. The severest shock occurred during the 11.4-mph hump, reaching 90g on the flatcar. Maximum on the trailer was 15.3 g at 200 cps. The electronic racks, mounted in

**MR. KIRCHMAN is Head of the Acoustic, Shock, and Vibration Unit, Aero & Structures Staff, at Martin's Baltimore division. He holds a BS in Aeronautical Engineering, Notre Dame, 1942, and is a member of NACA Sub-Committee on Aircraft Noise and a Member of Acoustical Soc. of Am. He has published a number of technical articles and papers, including "Low-Frequency Vibration in Aircraft," First Annual Meeting of the Institute of Environmental Engineers, 1957.**

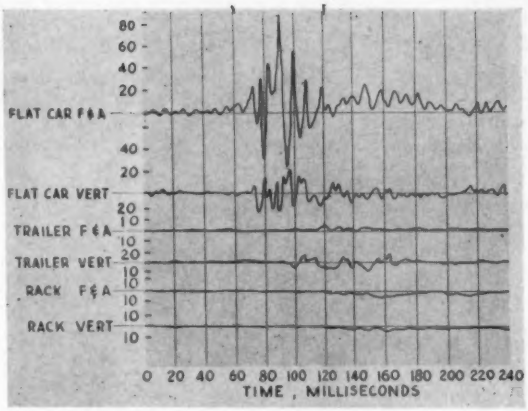



**Figure 2. Flat car trailer and rack accelerations, 11.36 MPH hump.**

| ACCELEROMETER NO. | | | 5 | 6 | 7 | 8 | 10 | 11 | 12 | 13 | 14 | 15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACCELEROMETER LOCATION | | | FLAT CAR REAR | TRAILER FLOOR REAR | FLAT CAR REAR | TRAILER FLOOR FRONT | TRAILER FLOOR FRONT | TRAILER FLOOR REAR | FLAT CAR REAR | FLAT CAR REAR | RACK BOTTOM SHELF | RACK TOP SHELF | |
| ORIENTATION | | | VERT | VERT | F-A | F-A | F-A | F-A | F-A | VERT | VERT | F-A | |
| ACCELEROMETER TYPE | | | GULTON | GULTON | GULTON | GULTON | MARTIN | STATHAM | STATHAM | GULTON | STATHAM | STATHAM | |
| FLAT RESPONSE CPS | | | 5-1000 | 5-1000 | 5-1000 | 5-1000 | 0-25 | 0-60 | 0-60 | 0-60 | 0-60 | 0-60 | |
| NO. OF CARS | HUMP MPH | | MAXIMUM ACCELERATIONS | | | | | | | | | | REMARKS |
| 1 | 4 | ACCEL g | NO RECORD | | | | | | | | | | NO APPARENT DAMAGE TO |
| | | FREQ CPS | | | | | | | | | | | BLOCKING OR TIE WIRES |
| 1 | 5.17 | ACCEL g | 13.9 | 2.9 | 38.0 | 1.0 | 2.9 | 1.0 | 13.0 | 10.9 | 1.7 | 1.9 | TIE WIRES LOOSENED |
| | | FREQ CPS | 200 | 50 | 100 | 200 | 10 | 100 | 200 | 200 | 8 | 20 | |
| 1 | 7.41 | ACCEL g | 18.0 | 8.8 | 68.5 | 12.2 | 6.3 | 7.0 | 44.0 | 17.0 | 2.6 | 3.3 | AFT DRAG BRACE FAILURE |
| | | FREQ CPS | 200 | 50 | 200 | 200 | 9 | 100 | 200 | 200 | 8 | 20 | CHOCK FAILURE |
| 2 | 5.37 | ACCEL g | 11.7 | 4.1 | 28.8 | 5.8 | 4.8 | 5.2 | 24.0 | 8.8 | 2.4 | 3.0 | CHOCKS REPLACED |
| | | FREQ CPS | 200 | 50 | 200 | 200 | 10 | 100 | 180 | 180 | 10 - | 20 | AFT DRAG BRACE FAILURE |
| 2 | 7.83 | ACCEL g | 18.0 | 8.0 | 94.0 | 12.3 | 7.4 | 8.3 | 41.4 | 8.8 | 4.9 | 5.8 | NO DRAG BRACE 2-WIRE TIES BROKE |
| | | FREQ CPS | 200 | 50 | 200 | 200 | 10 | 100 | 200 | 180 | 10 | 20 | CHOCKS COLLAPSED |
| 1 | 11.36 | ACCEL g | 22.0 | 8.5 | 90.0 | 15.3 | 8.0 | 5.8 | 44.0 | 19.3 | 4.6 | 4.4 | FRONT TOOT SPLIT |
| | | FREQ CPS | 200 | 50 | 200 | 200 | 8 | 100 | 200 | 200 | 8 | 18 | 4WIRE TIES LOOSENED |

**Figure 3. Maximum accelerations in humping test.**

20 to 30 cps, experienced a maximum of 4.6 g vertical and 4.4 g fore and aft.

The oscillogram for the 11.36 mph hump (Fig. 2) shows clearly the effect of the relative isolation of the racks from the trailer and the trailer from the flatcar. Figure 4 shows maximum acceleration versus humping speeds. A rapid increase in the fore and aft flatcar pick-ups is indicated in curves 7 and 12 while the rack pick-ups, 14 and 15, show a very gradual increase.

### Rough Road Tests

For the rough road test, the trailer was towed by an M-48 tractor. Figure 5 shows the instrumentation layout.

Although five circuits were made of the prescribed course, the six-foot corrugation was traversed only once since it was not considered applicable. This was the severest of the conditions and maximum acceleration developed (Fig. 6). In the typical oscillogram (Fig. 7), note the relatively high incidence of flow frequency for the lateral wall pickup as well as the 20 cps in the floor.

Figure 8 is a typical oscillogram taken in the Belgian block area of the course. For the most part, the frequencies are the same as for the six-foot corrugation, but are steady-state rather than single-impact in character.

In general, the equipment in the trailer was fairly well protected, and the isolators were effective in isolating high-frequency inputs through the base. Consider-

*(Continued on next page)*

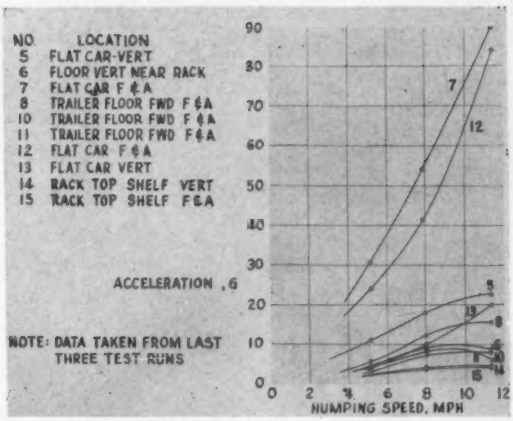

NO LOCATION
5 FLAT CAR-VERT
6 FLOOR VERT NEAR RACK
7 FLAT CAR F&A
8 TRAILER FLOOR FWD F&A
10 TRAILER FLOOR FWD F&A
11 TRAILER FLOOR FWD F&A
12 FLAT CAR F&A
13 FLAT CAR VERT
14 RACK TOP SHELF VERT
15 RACK TOP SHELF F&A
NOTE: DATA TAKEN FROM LAST THREE TEST RUNS
ACCELERATION, G
HUMPING SPEED, MPH

**Figure 4. Humping accelerations.**

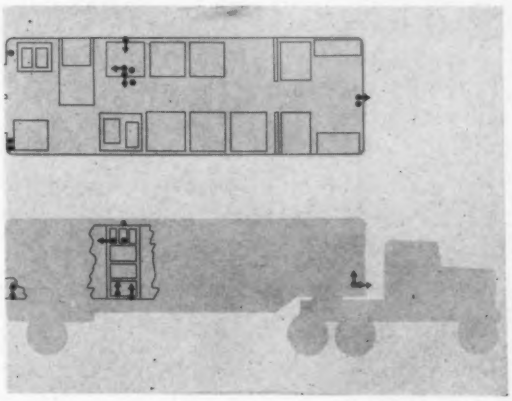


**Figure 5. Accelerometer locations in rough road test.**

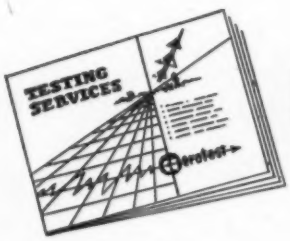
| ACCELEROMETER NO. | ACCELEROMETER LOCATION | ORIENTATION | TYPE ACCELEROMETER | FLAT FREQ RESPONSE | RECORD NO. 1 | | RECORD NO. 2 | |
|---|---|---|---|---|---|---|---|---|
| | | | | | ACCEL. | FREQ | ACCEL. | FREQ |
| | | | | CPS | g | CPS | g | CPS |
| 5 | TRAILER FLOOR LEFT - REAR | VERT | GULTON | 5-1000 | 7.6 | 150 | 6.4 | 150 |
| 6 | TRAILER FLOOR FRONT | VERT | GULTON | 5-1000 | 2.6 | 100 | 2.7 | 80 |
| 7 | TRAILER FLOOR RIGHT REAR | VERT | GULTON | 5-1000 | 3.5 | 100 | 5.0 | 100 |
| 8 | TRAILER FLOOR FRONT | F-A | GULTON | 5-1000 | 2.4 | 250 | 2.1 | 200 |
| 10 | RACK TOP SHELF | LATERAL | MARTIN | 0-25 | 3.5 | 9 | 3.9 | 9 |
| 11 | TRAILER FLOOR RIGHT REAR | VERT | STATHAM | 0-60 | 3.4 | 100 | 4.2 | 100 |
| 12 | TRAILER WALL NEAR TOP OF RACK | LATERAL | STATHAM | 0-60 | 4.4 | 9 | 4.0 | 9 |
| 13 | TRAILER FLOOR NEAR RACK | VERT | STATHAM | 0-60 | 2.1 | 9 & 100 | 2.3 | 100 & 9 |
| 14 | RACK BOTTOM SHELF | VERT | STATHAM | 0-60 | 2.5 | 9 | 2.8 | 9 |
| 15 | RACK TOP SHELF | F-A | STATHAM | 0-60 | 1.8 | 9 | 1.8 | 9 |

**Figure 6. Maximum accelerometers in road test. Six-foot corrugations, Munson Road Course, Aberdeen Proving Ground.**

AEROTEST

Serving industry with complete test facilities

- Environmental & Qualification Tests
- Design Evaluation Tests
- Research & Development
- Production Sampling Tests
- Test Equipment Design
- Inspection Methods & Procedures
- Quality Control Analysis




WRITE TODAY... for free copy of Aerotest's new illustrated brochure. Full description of facilities, services, etc.

Aerotest laboratories, inc.
129-11 18th AVENUE
COLLEGE POINT 56, N. Y.

*(Continued from preceding Page)*

able low frequency was present, however, particularly at the stabilizing mounts.

Further tests were made to determine the distribution and severity of typical road-induced loads, using the 200 miles of highway between New York and Baltimore.

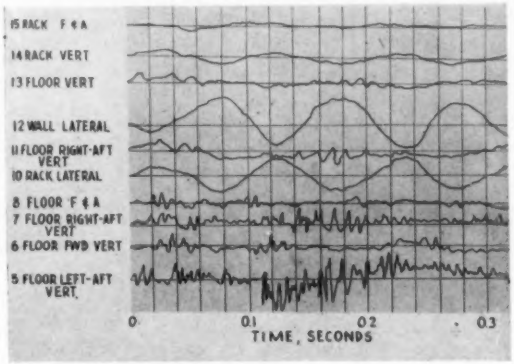



**Figure 7. Trailer and rack accelerations in rough road test—six-foot corrugations.**

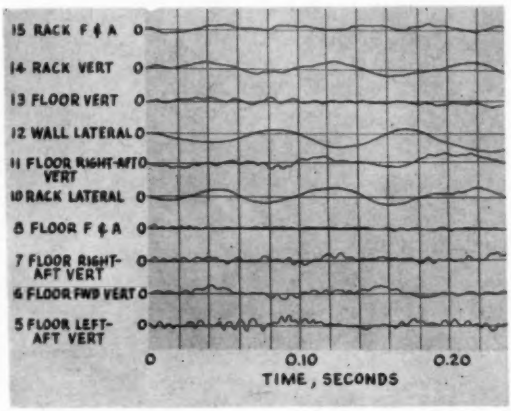



**Figure 8. Trailer and rack accelerations in rough road test—Belgian block.**

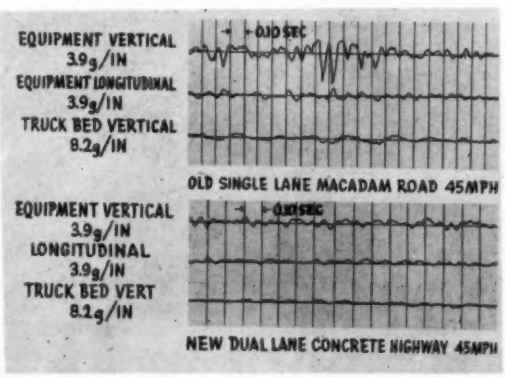



**Figure 9. Acceleration time histories in truck shipment of electronic equipment.**

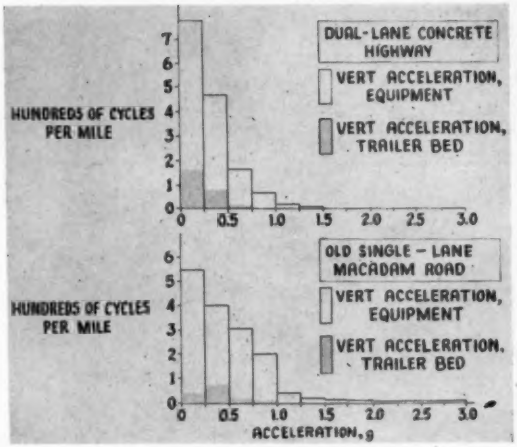



**Figure 10. Shock distribution during road shipment.**

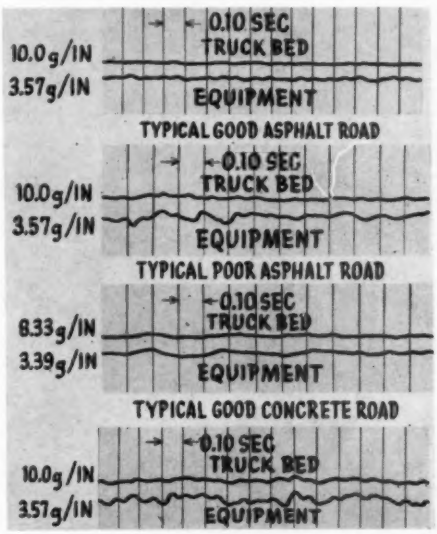



**Figure 11. Typical vertical accelerations.**

| CONDITIONS | EQUIPMENT ACCELERATION | | TRUCK BED VERT ACCELERATION | |
|---|---|---|---|---|
| | g | FREQUENCY CPS | g | FREQUENCY CPS |
| ASPHALT ROAD - GOOD | ± 0.11 | 15.4 | ± 0.10 | 15.4 |
| ASPHALT ROAD - FAIR | ± 0.24 | 3.2 | ± 0.25 | 3.2 |
| ASPHALT ROAD - POOR | ± 0.50 | 4.8 | ± 0.40 | 4.8 |
| CONCRETE ROAD - GOOD | ± 0.12 | 3.7 | ± 0.15 | 3.7 |
| CONCRETE ROAD - POOR | ± 0.44 | 13.3 | ± 0.35 | 13.3 |
| RAILROAD CROSSING | ± 0.43 | 2.5 | ± 0.30 | 2.5 |
| SLOWING TO STOP ON BAD ASPHALT ROAD | ± 0.11 | 2.2 | ± 0.50 | 2.2 |
| STARTING ON BAD ASPHALT ROAD | ± 0.27 | 2.8 | ± 0.25 | 2.8 |
| PATCH IN ASPHALT ROAD | ± 0.18 | 3.2 | ± 0.30 | 3.2 |
| PATCH IN CONCRETE ROAD | ± 0.71 | 14.3 | ± 0.60 | 14.3 |
| CONSTRUCTION ON ROAD | ± 0.41 | 3.0 | ± 0.42 | 3.0 |
| LOW-DIP STREET INTERSECTION | ± 0.44 | 11.8 | ± 0.25 | 11.8 |
| COBBLE-STONE STREET | ± 0.37 | 2.6 | ± 0.38 | 2.6 |
| ASPHALT BLOCK STREET | ± 0.29 | 10.9 | ± 0.25 | 10.9 |
| BRIDGE - GOOD | ± 0.18 | 3.0 | ± 0.20 | 3.0 |
| BRIDGE - POOR | ± 0.46 | 20.0 | ± 0.40 | 20.0 |

PLUS (+) UPWARD ACCELERATION
MINUS (-) DOWNWARD ACCELERATION

**Figure 12. Summary of vertical acceleration.**

A portable recording oscillograph and Statham accelerometers were carried, with one pickup mounted on the equipment and another on the truck bed. Typical records are shown in Figure 9.

In Figure 10, a plot of the distribution of road inputs is given for two typical conditions, a smooth concrete road and a macadam road. In this case, the object on the twist had an amplification factor of approximately 3.

Figure 11 shows additional oscillograms of typical road inputs.

Figure 12 shows the maximum g's experienced over a wide variety of road operation as well as the major frequency components.

### Evaluation

Humping test results may be summarized in this way. Equipment rigidly fastened to the bed of a railroad car may experience inputs up to 90g at a relatively high frequency. If the equipment is mounted directly in a trailer van that is secured to the railroad car, the loads are consistent with present design practices. Equipment mounted on appropriate isolators within the van experiences relatively light input during humping.

In rough road tests, the maximum g experienced by equipment mounted rigidly to the trailer floor bed was again consistent with present design practices. Equipment in correct mounts, or racks, was found to be well protected against the same condition. END

Attention

**ENVIRONMENTAL TEST ENGINEERS**

Here is the equipment you need for proving product reliability under all environmental conditions. Specializing in complete systems, we hope you will call on us regarding . . .

- *VIBRATION*—MB MANUFACTURING CO. A Division of Textron Inc.
- *SHOCK-ACCELERATION*—LYCOMING Division Avco Mfg. Corp.
- *ACCELERATION* (centrifugal)—AMERICAN MACHINE & FOUNDRY CO. Alexandria Div.
- *SOLAR HEAT*—GIANNINI PLASMADYNE CORP.
- *DYNAMIC MEASUREMENT* MB VIBRATION PICKUPS & METERS, COLUMBIA RESEARCH LABS. ACCELEROMETERS, CHADWICK-HELMUTH STROBE SCOPE AND CAMERA SYNCRONIZERS, LYCOMING TEMERATURE ACCELERATION INDICATORS

**EQUIPMENT SALES CO., INC.**

INDUSTRIAL REPRESENTATIVES — NEW ENGLAND, EASTERN NEW YORK

Dept. E
P.O. Box 6098
New Haven 17, Conn.
CHestnut 8-5581

Dept. E
393 Main Street
Stoneham 80, Mass.
SToneham 6-3206

from MB . . . everything you need for

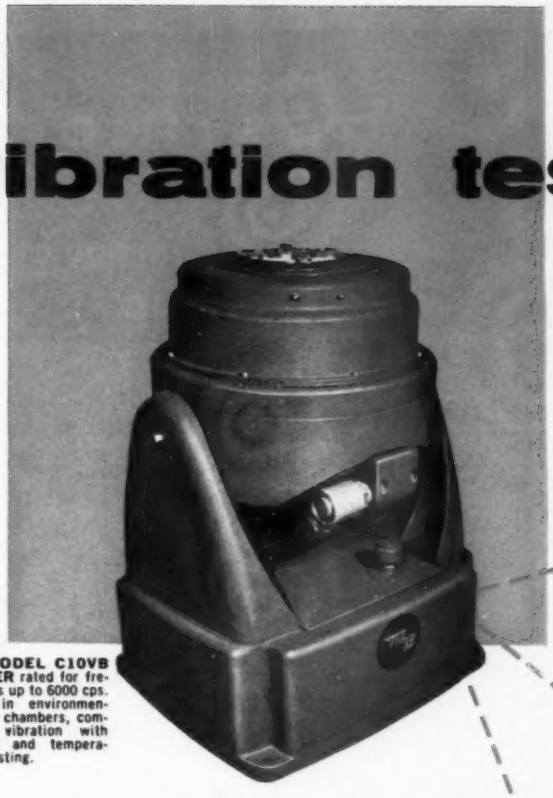
# complete, integrated

*Amplifier...vibration exciter...specialized matched controls*
*Engineered to satisfy existing test specifications*
*...with performance capability for the future*

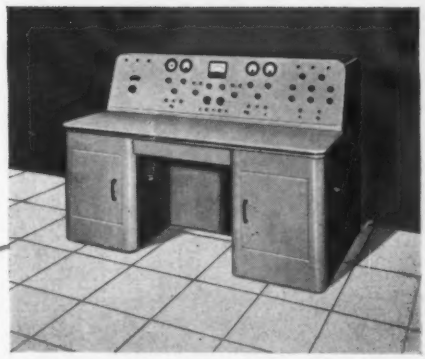
**MB T888 AMPLIFIER** being checked after assembly at the MB Plant. It provides broad frequency range and high power with extremely low distortion. Quality construction assures reliability and long life. Advanced design affords simplified operation.

***largest manufacturer of complete systems for vibration testing***

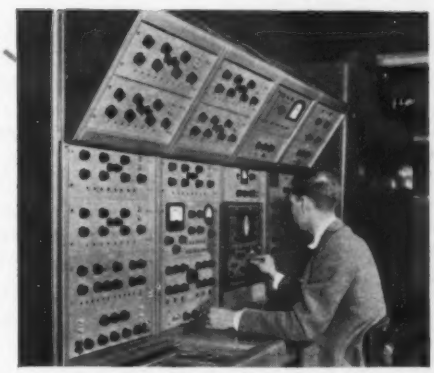
# vibration test systems



**MB MODEL C10VB EXCITER** rated for frequencies up to 6000 cps. Works in environmental test chambers, combining vibration with altitude and temperature testing.



**MODEL TEMC CONTROL CONSOLE** offers optimum control reliability. It is the only true servomechanism in the vibration testing field that integrates the error and reduces it essentially to zero.



**MODEL T88 COMPLEX MOTION CONSOLE** equips system for duplicating "noise" or random motion. Uniquely, it contains peak notch equalizer . . . which is an analog computer for giving exact inverse of the resonant response from specimen on the exciter.

VIBRATION testing grows more discriminating. First, sinusoidal testing; and now random and complex motions. Whatever *your* program, look to MB to keep you ahead. As the world's largest producer in its field, MB provides complete systems for advanced techniques.

Basically, *what you're really buying is the motion at the shaker table.* And nobody knows the requirements of the shaker better than its maker. MB builds equipment around the operational needs, thereby assuring optimum performance from system as whole, and from shaker specifically.

### MANY AMPLIFIERS IN SERVICE

MB has built over 850 electronic amplifiers for vibration test systems since 1945. More than 275 are 3 KW and larger. In advancing the science of complex motion testing, MB builds the required electronic gear with similar advanced thinking . . . to make it easier to use, and fit for future needs.

### SOME FEATURES

MB amplifiers feature automatic operation. Push a button to start. No need to fuss with filament and plate voltages. Amplifier can be remotely located to cut down noise and heat and save floor space at test location. Control console facilitates automatic or manual sine wave testing. The compensation console equips system for rapid setup and high fidelity complex motion work.

The largest field service organization of vibration specialists are on call nationwide to users of MB test systems. They provide technically qualified service on the *whole system.*

| TYPICAL PERFORMANCE OF SYSTEMS | | | |
|---|---|---|---|
| Amplifier Model | Exciter Model | Sine Force pounds | Random Force pounds |
| T444 | C10VB | 1750 peak | 850 rms |
| T666 | C25H | 3500 peak | 2500 rms |
| T888 | C25HB | 5000 peak | 3500 rms |

**SEND FOR COMPLETE DATA**

*MB manufacturing company*

A DIVISION OF TEXTRON INC.

1057 STATE STREET
NEW HAVEN 11, CONN.

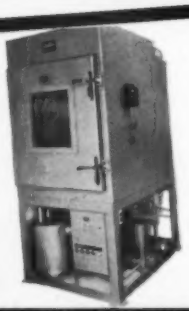
Standard CABINET COMPANY

*SPECIALISTS IN TEST EQUIPMENT*

# DESIGNED FOR DEPENDABILITY AND ACCURACY

TEMPERATURE ALTITUDE HUMIDITY

Versatility plus dependability. −100°F, +200°F, 100,000 ft. altitude, 20% to 95% relative humidity. Other environmental extremes and walkin facilities to individual specifications.



RAIN AND SUNSHINE

Designed to MIL-E-5272A, Par. 4.9.1 and 4.10.1. Rugged construction . . . attractive appearance . . . self-contained . . . 18 cu. ft. and 36 cu. ft. chambers . . . walkin sizes to meet your specifications.

Dependable operation when you need it . . . Accuracy that is so necessary for correct tests . . . both are an engineering "must" that is built into every Standard test cabinet. Standard equipment available whatever simulated environmental condition is required . . . altitude, temperature, humidity, rain, fungus, sand and dust, salt spray or explosion. You will also find Standard Cabinet prepared to design and fabricate test units geared to your special requirements. Send for our illustrated brochure or, better st'll, call us right now . . . our engineers are at your disposal.

*Write For Our Illustrated Brochure No. 59*

Member of Environmental Equipment Institute

Standard CABINET COMPANY

49 Washington Avenue
Carlstadt, New Jersey
GEneva 8-1500

COMPLETE
**TESTING FACILITIES**
with complete engineering
"KNOW-HOW"

ALTITUDE
TEMPERATURE
HUMIDITY
ACCELERATION
FUNGUS
RAIN
SUNSHINE
VIBRATION
EXPLOSION
SHOCK
SAND AND DUST
SALT SPRAY
RADIO NOISE
IMMERSION

As a pioneer in the design and development of equipment and "know-how" techniques in environmental testing . . . General Testing Laboratories offers you these advantages:

1. Our competent staff of engineers and technicians, many with a decade of experience in this line, are available for analyzing and helping you with your environmental testing requirements, in compliance with industrial and Government specifications including MIL-E-5272A and related tests.

2. To assure accurate and dependable tests, our modern, up-to-date equipment is devoted exclusively to giving quick service and reliable data for the proving of your products under any weather and environmental condition.

Phone or write today
for a personal discussion
of your test problems.

G L

**GENERAL TESTING LABORATORIES INC.**

65 WASHINGTON AVE. CARLSTADT, N. J.
WEBSTER 9-6933

# NEW EXECUTIVE COMMITTEE OF THE EEI

**Member**

NICK MILLER
Sales Mgr., Murphy & Miller, Inc.

**Member**

MONROE SELIGMAN
Pres., Tenney Engineering, Inc.

**President**

R. J. JACOBSON
Pres., Cincinnati Sub-Zero Products

**Executive Vice President**

CHARLES C. E. HARRIS
Pres., Harris Refrigeration

**Member**

JACK SHAMROTH
Pres. American Research Corporation

# *E E I Fifth Annual Meeting*

The Environmental Equipment Institute held its fifth annual meeting on April 16 in New York City on the eve of its annual environmental equipment conference which is traditionally planned to coincide with the annual meeting of the Institute of Environmental Engineers. New president is R. J. Jacobson, President, Cincinnati Sub-Zero Products.

All of the new officers for the fiscal year ending next April are shown in the photographs above. Together with E. S. Brown, Pres., Standard Cabinet Co., and junior past president of EEI, and Dr. George D. Wilkinson, General Manager, these men comprise the EEI Executive Committee. Dr. Wilkinson is President of the George D. Wilkinson Associates, a firm of consultants in management, with offices in Princeton, N. J. He is also General Manager of the Institute of Environmental Engineers.

During the meeting, President Jacobson appointed a Membership Drive Committee, with Robert H. Brown, Vice President of Tenney Engineering, Inc., as Chairman. Other members are: Nick Miller, Sales Manager, Murphy & Miller, Inc., Jack Shamroth, President, American Research Corp., and Saul Schiffman, Chairman of the Board, Tenney Engineering, Inc.

Others attending the meeting were: Dr. Bruno Sachs, Tenney Engineering, Inc.; Ted Augustyne, American Research Corp.; Don Romine, International Radiant Corp.; Don Haskins, Murphy & Miller, Inc.; Charles C. E. Harris, Harris Refrigeration; and Henry Broad, EEI Counsel, of Princeton, N. J.

### Equipment Conference

The environmental equipment conference held in conjunction with the Annual Meeting of the IFE included, in addition to the EEI members, AVCO Advanced Research and Development Division, and Consolidated Electrodynamics Corporation. EEI members maintained booths staffed with engineers and officers and were constantly available for consultation. The other two booth-holders demonstrated environmental equipment.

Committee on arrangements for the equipment conference included E. S. Brown, Robert H. Brown, Jack Shamrock, and Dr. Wilkinson.

---

**1959**

***ENVIRONMENTAL EQUIPMENT CONFERENCE***

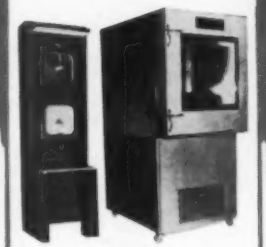
**In Chicago Next April**

**For *Booth Information*, Write To**

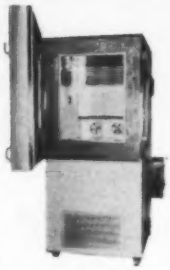
**Environmental Equipment Institute**

**9 Spring St., Princeton, N. J.**

Tenney chambers ANOTHER FIRST FROM THE LEADER



TENNY THIRTY
30 CUBIC FEET



TENNEY TEN
10 CUBIC FEET

TENNEY-MITE
1½ CUBIC FEET

"FIRST AND FOREMOST IN ENVIRONMENTAL TEST EQUIPMENT"

*Lowest cost — highest quality*

MECHANICALLY REFRIGERATED TEST CHAMBERS IN THE INDUSTRY

Tenney Engineering, first in the manufacture of environmental test equipment, again demonstrates its leadership. ANSWERING THE INDUSTRIAL DEMAND, Tenney offers a new series of low cost, high quality environmental test chambers . . . for high and low temperature applications in the range of −120°F to +350°F. Relative humidity is optional in the Series Ten and Series Thirty.
Write us a letter outlining your test problems, and we will suggest a chamber to fit your requirements.

Tenney ENGINEERING, INC.

1090 SPRINGFIELD ROAD
UNION, N. J.
PLANTS: UNION, N. J.
AND BALTIMORE, MD.

## B. T. ACCELEROMETERS

*(Continued from page 6)*

The accelerometers showed negligible variation in sensitivity after exposure to our shock tests.

Table 3 presents accelerometer sensitivity evaluation before and after exposure to a salt spray test and a rainfall test for Model B-I. Two of the three accelerometers exposed to the salt spray environment failed to function thereafter.

The three accelerometers exposed to the environment of rainfall in accordance with MIL-E-5272A, Paragraph 4.10.1, Procedure 1, showed sensitivity variation of less than 2%. End

**TABLE IV**

**Results of Sensitivity Study on B. T. Accelerometer before and after Rainfall and Salt Spray Tests.**

| Serial No. | Sensitivity Before Climatic Test (mv/G) | Sensitivity After Climatic Test (mv/G) | Specific Climatic Test | Remarks |
|---|---|---|---|---|
| B-I-9 | 15.0 | 15.1 | Rainfall | Accelerometers complied with specification. |
| B-I-10 | 17.6 | 18.2 | MIL-E-5272A Par. 4.10.1 | |
| B-I-3 | 15.4 | 15.9 | Procedure I | |
| B-I-6 | 17.5 | No Output | Salt Spray | Accelerometers did not comply with reference specification |
| B-I-2 | 18.1 | 16.5 | MIL-E-5272A Par. 4.6 | |
| B-I-1 | 14.7 | No output | | |

# Professional Cards

*a new department*

60 FOREST ROAD • MURRAY HILL, NEW JERSEY

**Dearco Associates**

SPECIALISTS IN REPORTS & TECHNICAL PUBLICATIONS

*EDITING · DESIGN · ARTWORK*
*REPRODUCTION PAGE MAKEUP*
*PRINTING AND BINDING*

---

*GEORGE D. WILKINSON*
*ASSOCIATES*
*Consultants in Management*

9 Spring St. Princeton, N. J.

---

**TEST LABS, CONSULTANTS, ETC.**

Write
**Environmental Quarterly**
9 Spring St., Princeton, N. J.

*For Details on Presenting*
**Your Card Here**

---

**PARAMETERS, inc**

**ENVIRONMENTAL-FUNCTIONAL TESTING**

**195 Herricks Rd.**
**New Hyde Park, N. Y.** **Pioneer 6-0155**

---

*Bruno J. Forsher*
**MECHANICAL ENGINEER**
**ENVIRONMENTAL SIMULATION & RELIABILITY**
**2102 Manning Ave., W. Los Angeles 25** **Granite 3-0260**

---

**N. J. Dynamic Test Lab**

Consultants on Dynamic Deformation Problems
Analytical Evaluation of Structural Designs

**MFRS OF**
**Shock Machines**
**Vibration Machines**

**DYNAMIC TESTING OF**
**Cushioning Materials**
**Guided Missile Components**

Livingston, N. J.
Box 32
Tel. LI 6-1496

**J. T. MULLER**
Consulting Engr.

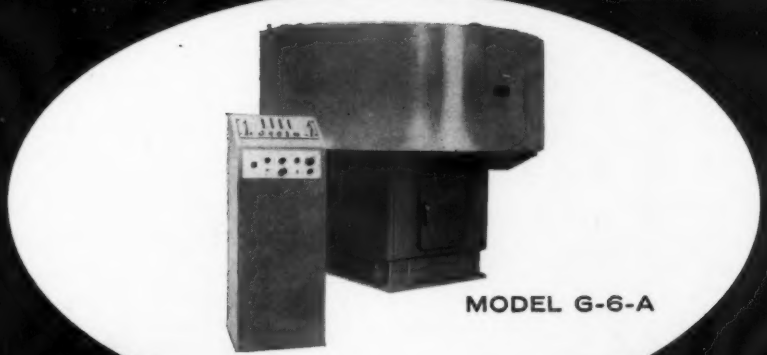
---

THIRD ANNUAL MEETING
I. E. E.
*April 1959, Chicago*
If you would like to present a paper, please
write to *Raymond Yaeger,* Program Chairman
*Chrysler Missile Div., P. O. Box 2628, Detroit 31, Mich.*

---

***For Acceleration Testing Equipment***

**All models conform to MIL-E-005272B (USAF)**




**schaevitz**

**SCHAEVITZ MACHINE WORKS**
PO BOX 505
CAMDEN 1, N. J.
NOrmandy 2-8000

**WHICH SIZE SUITS YOUR NEEDS?**

| MODEL NO. | ARM SIZE (DIA.) |
|---|---|
| 20 HG | 8 INCHES |
| C-1-A | 20 INCHES |
| C-3-A | 34 INCHES |
| M-2-A | 24 INCHES |
| G-4-A | 56 INCHES |
| G-6-A | 74 INCHES |
| B-8-A | 8 FEET |
| B-10-A | 10 FEET |
| B-12-A | 12 FEET |
| T-13-A | 13 FEET |
| T-16-A | 16 FEET |
| A-35 | 35 FEET |

# *Heat Transfer With Electrodynamic Vibration Exciters*

WAYNE TUSTIN, Sales Engineer, MB Mfg. Co.
ARTHUR SCHWARTZ, Chief Engineer & Vice-Pres., Atlas Engineering Corp.

With new environmenta ltest specifications calling for "combined environment" testing, vibration tests may at any time be required at extremes of temperature, altitude, humidity, or all three simultaneously. Techniques have been applied using a push-rod between vibration exciter and specimen, with the rod passing through the chamber wall and the shaker remaining outside. This is not a favored approach because resonances in the rod limit use to 500 cps maximum except for very light loads. Authorities claim that above 500 cps the shaker must be placed within the chamber so that the specimen may be bolted directly to the table.

When electrodynamic exciters are used inside test chambers, some means of dissipating the heat generated must be employed. Probably the earliest installation of an exciter inside an environmental chamber was at the Diamond Ordnance Fuze Lab, Washington, D. C., about four years ago. The heat transfer problem was attacked by the use of a temperature barrier between two compartments. The shaker was placed in the bottom compartment with its table extending upward into the other compartment. The barrier or baffle prevented excessive moisture condensation on the exciter, which was held at a lower temperature than the specimen compartment.

Forced air cooling is possible with an exciter in an altitude chamber but only with rather complex ducting and seals. Oil cooling is proving to be a satisfactory method for the removal of excess heat. Furthermore, without an obstructing baffle, testing in both horizontal and vertical planes is feasible

## Reasonable Approach

Our intention in the following discussion is not to develop exact heat transfer data, but rather to indicate a reasonable approach to estimating chamber and circulating oil heat loads involved in any installation..

Because heat transfer between fluids and a metal wall depends upon the film thickness of the fluids, and the film thickness is in turn dependent upon viscositv and velocity, the location of an exciter with respect to the air circulators has a great effect on heat transfer. With location directly in front of a fan or in any high velocity region, heat transfer at any temperature is at its maximum. In stagnant air, heat transfer is minimized.

The magnitude of the heat transfer may be approximated if it is assumed that the surface conditions of the exciter approach those occurring in conventional building construction. In estimating the heat transfer through building walls, the inside and outside air film heat transfer coefficients are taken, respectively, as 1.65 and 6.0. Inside air velocity is usually taken as 50 FPM, and outside air is normally taken as 15 MPH or 1300 PM. Figure 1 shows values of air film heat transfer coefficient "U" versus air velocity.

Another approach to the magnitude of air heat transfer coefficient is to assume that the exciter surfaces approach those of air heat exchangers. Also plotted in Figure 1 are typical values of

MAXIMUM CAPACITY...MINIMUM SIZE...for Environmental Testing

Model
ASU-120-6-HC
Altitude Test Unit

New 6 cu. ft. model for program testing with a temperature range of plus 300 to minus 100°F and a thermal capacity of 1200 BTU/hr. at −100°F. Equipped with temperature and altitude recording controllers. Altitude range at sea level to 90,000 feet. Chamber adapted to vacuum testing, and equipped with Fin Coil & Blower plus 2000-watt heater for mechanical air convection and optimum heat transfer.

Model A-120-2

This 2 cu. ft. unit is ideal for close temperature control testing of parts, equipment, finishes, etc. Has a range of minus 120° to plus 300° F., with a frost-proof observation window in hinged lid and interior illumination. Indicating control, fin coil and blower circulator and a 500 watt heater.

Cincinnati Sub-Zero offers a complete line of chambers designed for testing under conditions of low temperature, high temperature, various altitudes, atmospheric pressures, and humidities or combinations of these in complete programs of pre-determined conditions.

Specially - built, custom - designed units can also be furnished for specific programs, complete with fully automatic controls. Their flexibility offers an accurate method of simulating varying conditions for preset time intervals. For complete details, write us and outline your testing requirements.

Write TODAY for Complete Line Catalog #102

Cincinnati Sub-Zero Products
General Offices and Plant
Reading Road at Paddock Cincinnati 29, Ohio

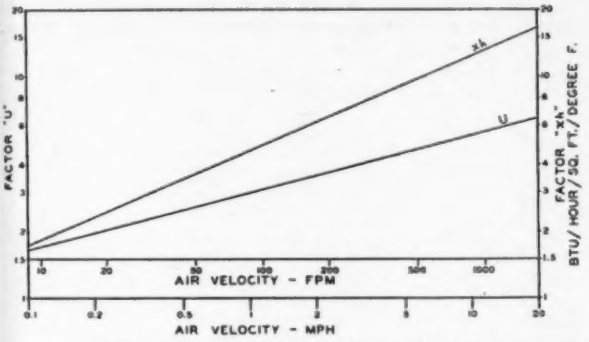



**Figure 1. Heat loss factors as related to wind velocity**

"xh", the air film heat transfer coefficient commonly used in heat exchangers.

### Paint vs. Bare Metal

If the exciter housing is painted, the coefficient approaches the former curve "U"; if it is bare metal, the coefficient approaches the latter curve "xh". In any event, a generous safety factor should be taken until more experience is gained with the available exciters. We recommend a safety factor of 25%.

The resistance to heat transfer due to the metal outer housing of the exciter and the film of oil circulating inside the housing may be neglected without great error, and Figure 1 may be used directly in estimating heat loads. In selecting the heat transfer coefficient, the air flow past the exciter may be estimated if it is

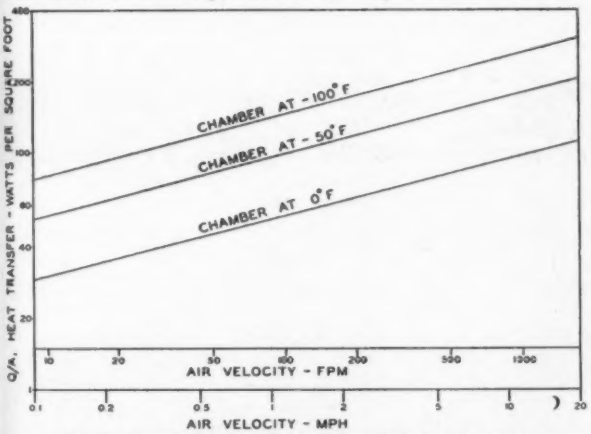



**Figure 2. Heat transfer from exciter to chamber**

remembered that chamber circulation fan outlet velocities are about 3,000 FPM; if the exciter is directly in front of the fan discharge, this will be the velocity of the air. Remember also that air naturally spreads at an included angle of 15°. If the air volume circulated is known, velocity at any distance from the discharge may be estimated.

Oil-cooled exciters require an oil temperature between +60°F and +120°F. Thus it may be necessary to heat and/or cool the oil in a given installation.

The heat transfer is given as:

$$Q = UA\Delta T$$

where Q = the heat transferred in BTU per hour
U = the over-all heat transfer coefficient (Fig. 1)
A = the area of the exciter through which heat is transferred, in square feet
$\Delta T$ = temperature difference between the oil and the air in degrees F

*(Continued on next page)*

**THE ONLY INDEPENDENT COMMERCIAL ENVIRONMENTAL TEST LAB IN THE BOSTON AREA**

Acton Laboratories provide defense contractors, industry and government agencies with the most completely equipped environmental testing facilities in the Boston area. Only the most modern, most precise instruments and equipment are used. Acton's Environmental Testing Laboratory is staffed by experienced personnel with the important "know-how".

Instrumentation and facilities conform to standard military testing specifications as well as tests for manufacturer specifications.

*Complete testing facilities for . . .*

- High Temperature
- Low Temperature
- Humidity
- Altitude
- Mildew-Fungus
- Salt Fog & Salt Spray
- Sand & Dust
- Explosion
- Sunshine & Rain
- Vibration — High and Low Frequency
- Shock
- Acceleration
- Life Tests

*Write for free brochure*

*containing complete details.*

ACTON LABORATORIES
529 MAIN STREET, ACTON 1, MASS.
COlonial 3-7756, Boston Line LIberty 2-2681

# EXPLOSION TESTS

**PER MIL-E-5272A PROCEDURES I AND II**

The testing of components and equipments to the exacting requirements of MIL-E-5272A requires skill and experience.

Here at United States Testing Company the facilities and personnel are readily available to support the efforts of your own test group, or if you so desire, we will set up and conduct your entire test program on explosion tests or any of the tests outlined by MIL-E-5272A.

*Call or write us for details without obligation.*

**UNITED STATES TESTING COMPANY, INC.**

ESTABLISHED 1880

2040 Park Avenue, Hoboken, N. J.

BOSTON • BROWNSVILLE • DALLAS • DENVER • LOS ANGELES

MEMPHIS • NEW YORK • PHILADELPHIA

PROVIDENCE • SAN ANGELO


To get heat loss per square foot of area, the equation may be transposed to a more useful form. Further, heat loss units of watts are more useful than units of BTU per hour.

$$Q = UA\triangle T$$
$$Q = U\triangle T$$
$$3\text{-}416$$

In Figure 2 may be found values of Q/A, as a function of air velocity, for several typical chamber temperatures: 0°, —50°, and —100°F. Figure 3 gives similar Q/A values for chamber temperatures of +160°, +200° and +300°F. Figure 2 is based on oil at +60°F while Figure 3 is based on oil at +120°F.

Let us examine a numerical value, using the 5,000 pound force Model C25HB in a chamber at —100°F. A typical installation may find the exciter located in an air velocity of 1,000 FPM. From Figure 2, a value Q/A—260 watts per square foot is selected. This exciter has a total area of 43 square feet. Thus a heat loss of (260) (43) or 11,200 watts will occur.

The electrical input to this exciter will vary between 2,000 watts (field excitation only, no audio power to drive coil) and 24,500 watts (full power). Whenever the electrical input is less than the heat loss, the oil temperature will drop below its allowable minimum of +60°F. To prevent this, up to 9,200 watts of heat must be supplied to the oil. Auxiliary electrical heaters are provided for those installations where they are required.

(*Continued on page* 25)

## Rudkin of Arma Wins Again For N. Y. Chapter of I E E

For the second time in succession, award of plaque by the IEE to the local chapter obtaining the most new members each quarter goes to the New York Chapter. Robert H. Rudkin, the Chapter's Membership Chairman, is shown here (left) receiving the coveted plaque from Dr. George D. Wilkinson, IEE General Manager, during the first day luncheon at the Institute's Second Annual Meeting last April.

The list of new IEE members appearing elsewhere in this issue reveals an unprecidented spurt in membership, and a particularly large increase for the New York area.

# NEW IEE MEMBERSHIPS

*Since the last issue. Where home addresess are shown, company affiliations appear in parentheses.*

**MEMBERS**

### *California*

Philip C. Bean, University of California, Radiation Lab., Berkeley
Frank D. Schwark (Rocketdyne Div. of NAA) 21704 Parthenia Street, Canoga Park
Benjamin Hayashida, Hughes Aircraft, Florence & Teale Streets, Culver City
James A. Sneller, Mantec, Inc., 126 Maryland Street, El Segundo
John S. Windle, Wyle Laboratories, 128 Maryland St., El Segundo
Kenneth L. Guler (Rocketdyne Div. of NAA), 4837 Haywenhurst Ave., Apt. 6, Encino
Charles S. Mayo. Sundstrand Turbo, 10445 Glenoaks Blvd., Glenoaks
Cyril E. Makerov, University of California, Radiation Lab., P. O. Box 808, Livermore
James A. Ross, Ling Electronics, 5120 W. Jefferson Road, Los Angeles
Gordon Young (Douglas Aircraft Co.) 2113 Roscomare Road, Los Angeles
Howard C. Zintz, the Rucker Co., 4700 San Pablo Ave., Oakland
Frank D. Abarta, Lockheed Missile Systems Div., Palo Alto
John D. Campbell, Philco Corp., G. & I Div., 3875 Fabian Way, Palo Alto
Richard M. Beattie, Aerojet-General Corp., P. O. Box 1947, Sacramento
Ray G. Danehy (Ettel McCullough); 761 Santa Lucia, San Bruno
Lawrence E. Anderson (Ryan Aeronautical Co.), Lindbergh Field, San Diego
Mitchell P. Christensen (San Diego Testing Labs., Inc.), 118 W. Brookes Ave., San Diego
Kauko Kuoppamaki, Lockheed Aircraft Corp., Missile Systems Div., Sunnyvale
James D. Sakols, Lockheed Aircraft Corp., Missile Systems Div., Sunnyvale

### *Canada*

Allan E. Hill, Canadian Westinghouse, Electronics Division, Environmental & Appraisal Lab., Box 510 Hamilton, Ontario
Donald F. Beechy (Conrad Inc.), 290 Lawrence Ave., Ext., Toronto 12, Ontario
John W. A. Gleason, 150 Perth Avenue, Toronto, Ontario
Edward S. Adams, J. H. Lock & Sons Ltd., 874 Clyde Ave., Ottawa
Alec S. Hesketh, Aviation Electric Ltd., 200 Laurentian Blvd., Montreal 9, Québec
William K. Kenrick (Canadian Ltd.), 227 Monseigneur Prevast, St. Eustache, Prov. of Quebec
John M. Tol (Canadair Ltd.), 2062 St. German Blvd., St. Laurent, Prov. of Quebec

### *Colorado*

John F. Clark Jr. (The Martin Co.), 3266 S. Wolff Street, Denver 23
George N. Crawford (The Martin Co.), 835 S. Everett, Denver 15
Paul Locklin, Alta Engineering Co., P. O. Box 213, Englewood

### *Connecticut*

Isadore Levine (General Precision Labs.), 183 Bronx Ave., Bridgeport
William Arnott (Burndy Corp.), Mill Road Silvermine, New Canaan
Nicholas T. Maffei (General Precision Lb.), 41 Culldden Road, Stamford
Adam M. Wilczenski, Torrington Mfg. Co., 100 Franklin Drive, Torrington

### *District of Columbia*

Carl J. Wessel, Prevention of Deterioration Center, National Academy of Sciences, National Research Council, 2101 Constitution, Washington 25

### *Illinois*

Ernst A. Corduan (Vapor Heating Corp.), 405 S. Prinelle Ave., Arlington Heights
Walter H. Holze, Flexonics Corporation, 840 N. State Street, Elgin
Lawrence J. Eilers, Admiral Corp., 3800 W. Cortland, Chicago 47
Paul Cottfield (Inland Testing Lab.), 4908 N. Sheridan Road, Chicago 40
Patrick W. Linehan, Motorola, 2710 N. Clybourn, Chicago
William O. Nostrand (Conrad Inc.), 1249 W. Glenlake Ave., Chicago
Joseph P. Wajda, Amphenol Electronics Corp., 1830 South 54th Ave., Chicago
Marvin E. Holmgren, Sundstrand Aviation, 2421 11th Street, Rockford

### *Indiana*

Morton Barov, Farnsworth Electronics Co., 2700 East Portian, Fort Wayne
Harry G. Lorick, Allison Div. of GMC, Tibbs Avenue Plant 8, Indianapolis
Wayne E. Cofoid (Linde Co.), 1663 De Soto Lane, Speedway 24

### *Maryland*

James T. Rudie, Westinghouse Electric Corp., 3601 Washington Blvd., Baltimore
Paul D. Sales (C. W. T. Medical Research Labs.), 432 Santa Main St., Bel Air

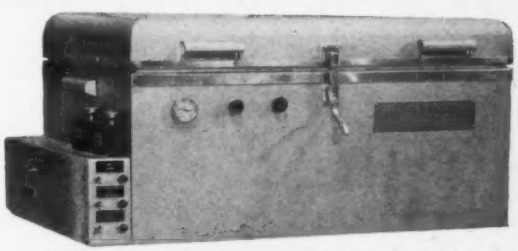
*(Continued on Next Page)*


*Wide Range*

● Bemco, Inc. has anticipated the need for higher performance in a one to two cubic foot BENCH TYPE —100° F. TO +650° F. TEST CHAMBER. Includes all steel construction, stainless steel inside, cold rolled outside, 4" insulation, continuous air circulation, close control, and many other features found only in large chambers.

With dry ice as the refrigerant, the DF-100/650-1 provides one cubic foot of clear test space. Two cubic feet are provided when used as an oven.

● This is only one item in Bemco's complete line of environmental equipment providing any condition of altitude, vacuum, temperature, humidity, sand and dust, salt spray, explosion, sunshine and rain. Many types of chambers are available for immediate delivery from stock on a rental or purchase basis. Write for the new forty-five page Bemco Environmental Equipment Manual.



MODEL DF-100/650-1 — $585.00, F.O.B. BEMCO, INC.
Immediate Delivery from Stock

BEMCO INC.
ENVIRONMENTAL TEST EQUIPMENT DESIGN AND MANUFACTURE
11631 VANOWEN STREET • NORTH HOLLYWOOD, CALIFORNIA • MEMBER OF THE E.E.I.

Quality — Performance — Economy

Announcing the NEW

ThermaLine

TESTING CHAMBERS

FOR SIMULATION OF:

- Ultra-Low & High Temperatures
- High Altitudes
- Precision Humidity

ThermaLmite

"A VALUE LEADER"

- 2.6 cubic feet
- 20" high x 15" wide x 15" deep

ThermaLmaster

- 12 cubic feet
- 36" high x 24" wide x 24" deep

ThermaLmonarch

- 36 cubic feet
- 48" high x 36" wide x 36" deep

WE OFFER:

- SERVICES of an engineering staff who have pioneered in the development and manufacture of environmental simulation equipment.
- EXPERIENCE in engineering and manufacture of such major installations as walk-in, drive-in temperature, humidity, altitude test facilities complete with cooling air simulation.
- CAPABILITIES: To create facilities to meet your testing requirements.

ENGINEERS • CONSULTANTS • MANUFACTURERS

INTERNATIONAL RADIANT CORP.
111 New York Ave., Westbury, N. Y.
EDgewood 4-8820

**IEE MEMBERSHIPS** *(Continued)*

*Massachusetts*

L. W. Fish, Jr., Acton Labs., Inc., 533 Main St., Acton
Robert J. Schreiber, Raytheon Mfg. Co., Andover Plant, Andover
Charles Cohen (Research & Advanced Development Division Avco Manufacturing Corporation), 29 Colgate Road, Beverly
Morris M. Knepp (Sylvania Electric Products), 24 Foster Drive, Framingham
Curtis D. Melvin (Raytheon Mfg. Co.), 132 State St., Framingham Centre
Simon Malkin, Raytheon Mfg. Co., Woburn Street, Lowell
James G. Kakatsakis (R.A.D. Division Avco Mfg., Co.), 35 Evelyn Road, Needham Heights
Peter H. Fowler, Raytheon Mfg. Co., 55 Chapel Street, Newton 58
James K. Young (Raytheon Mfg. Co.), 2 Marchall Street, North Reading
Walter J. Gnacek (G. E.), 30 Plunkett Street, Pittsfield
Edward A. Wood, Jr., (Raytheon Mfg. Co.), 37 Lafayette Street, Waltham 54
Peter T. Goethel, Barry Controls, 700 Pleasant Street, Watertown
Warren Thornley, Raytheon Mfg. Co., Wayland Lab., Box 140, Wayland
Edward J. Lunney (Avco Advanced R & D Div.), 10 Redwing Road, Wellesley 82
Edward L. Lavine, Calidyne Co., 120 Cross Street, Winchester

*Michigan*

Jack A. Delaney, Detroit Testing Laboratories Inc., 554 Bagley, Detroit 26
Alan J. Howell, Chrysler Corporation, Missile Division, Box 2628, Detroit 31
Oluf R. Hansen, Jr. (Chrysler Corporation), 5800 Streefkerk Drive, Apt. A-3, Warren

*Minnesota*

Harry T. Christenson, Minneapolis Honeywell Regulator Company, 26 Ridgeway Road, Minneapolis
Gerold L. Dolon, Remington Rand Univac, Univac Park, Saint Paul 16

*Nebraska*

Glenn W. Carter (Dale Products Inc.), 3111 21st Street, Columbus

*New Jersey*

Basil Lavitol, Picatinny Arsenal (SFAL), Dover, Attn: ORDBB-TO3
James R. Le Savage, 520 Undercliff Avenue, Edgewater
W. Carlisle Huckabee, U. S. Testing Co., 1415 Park Avenue, Hoboken
J. Robert Tucker, U. S. Testing Co., 1415 Park Avenue, Hoboken
Carl B. Yoder, U. S. Testing Company, 1415 Park Avenue, Hoboken
Joseph F. Beattie (Calidyne Company), Box 234, Morris Plains
Roy H. Woodin, Federal Telecommunications Laboratories, 500 Washington Avenue, Nutley
Harvey A. Nickerson, Resistoflex Corporation, Woodland Road, Roseland
Edward H. Jones, Bell Telephone Laboratories Inc., Whippany

*New York*

George A. Yabroudy (Arma Div. American Bosch Arma Corp.), 876 Countryline Road, Amityville
Guther A. Adler (Sperry-Gyroscope Co.), 69-67 228th Street, Bayside, L. I. 64
Murray P. Baker (General Precision Laboratories), 2144 Crotona Parkway, Bronx
John A. Coons, Cornell Aeronautical Lab., Inc., 4455 Genesee Street, Buffalo 21
Russell A. Hoffman (Hazeltine Electronics Division), 20-43 120th Street, College Point 56
Richard S. Silverman, Aerotest Labs. Inc., 129-11 18th Avenue, College Point 56
David A. Drucker (Arma Division, American Bosch Arma Corp.), 128-20 31st Road, Flushing 54
Edward M. Brown (V. A. Snyder Co.), 27 W. Woodbine Drive, Freeport
Angelo J. Boscia, Arma Div., American Bosch Arma Corp., Garden City
Victor P. Ceparana, Arma Div. American Bosch Arma Corp., Garden City
Melvin Feinberg, Arma Div., American Bosch Arma Corp., Garden City
John B. Leonard, Jr., Arma Div., American Bosch Arma Corp., Garden City
Theodore Plotkin, Arma Div., American Bosch Arma Corp., Garden City
John J. Regazzi, Arma Div., American Bosch Arma Corp., Garden City
Saul R. Jupiter, Aircraft Porous Media Inc., 30 Sea Cliff Avenue, Glen Cove
Emil Bruno, Sperry Gyroscope Company, Markus Avenue, Great Neck, L. I.
Jesse Markowitz, E.R.A. Inc., 340 Great Neck Road, Great Neck
Richard G. Jamison (Arma Div., American Bosch Arma Corp.), 11 Woodlands Road, Harrison
Stanley J. Woodcheke (Arma Div., American Bosch Arma Corp.), 16 Ferndale Drive, Hicksville, L. I.
Donald J. Shergalis (Grumman Aircraft Engineering Corp.), Violet Drive, R. F. D. #4, Huntington, L. I.
Carmine J. Colaluca, Jr. (Republic Aviation Corp.), 20 Wallingford Drive, Huntington Station, L. I.
Thomas F. Hanley, Jr. (Burgoyne Testing Labs.), 11 Avenue & W. 22nd Street, Huntington Station, L. I.
Vernon A. Smith, G. E., 600 Main Street, Johnson City
Edward Bermay (Gulton Industries, Inc.), 34-50 24th Street, Long Island City 6
William Santo (General Precision Labs.), 29 Jolen Drive, New City
James R. Le Sauvage, New York Testing Labs., 57 West Street, New York City
John G. Piob, Burns & Roe Inc., 160 W. Broadway, New York 13
Alex F. Soprou, McConathy Hoffman & Associates Inc., 10 Columbus Circle, New York 19
Salvatore B. D'Avola, General Precision Labs., 63 Bedford Road, Pleasantville
Edward J. McCormick, General Precision Labs., 63 Bedford Road, Pleasantville
Howard B. Leake, Stromberg Carlson Company, 100 Carlson Road, Rochester 3
William R. Contin (Arma Div., American Bosch Arma Corp.), 32 Cotlin Avenue, Roosevelt, L. I.

Richard J. Wells, General Electric Co., Building 37, Room 602, Schenectady
Gilbert F. Hill, L. A. B. Corp., Skaneateles
Walter S. Calvert, Specialties Inc., Syosset
Ronald G. Lambert, G. E., French Road, Utica
Salvatore P Mercurio, General Electric Co., French Road, Utica
Andrew H. Gelderman, (Grumann Aircraft Engineering Corp.), 2869 Morgan Drive, Wantagh, L. I.
Kenneth G. Leib (Sperry Gyroscope Co.), 3086 Beltagh Avenue, Wantagh
Herman F. Bohnhorst (Sperry Gyroscope Co.), 272 Tyrconnel Avenue, Wassapegua Park, L. I.
Frank Culmone (Fairchild Camera & Instrument), 28 Woodoak Drive, Westbury, L. I.
Vincent Atalese, Norden Labs., 121 W. Moreland Ave., White Plains

*North Carolina*

James P. Epperson, Western Electric Co., Dept, 222, Chatham Road, Winston-Salem

*Ohio*

John L. Cahill (G. H. Leland, Inc.), 300 Lawyer Lane, Dayton 31
Dale Tower, Tower Engineering Co., 627 Salem Ave., Dayton 6
Joseph T. Zeigler, Joy Manufacturing Co., New Philadelphia

*Pennsylvania*

Edward M. Toleikis (RCA), 416 Langford Road, Broomall
Kenneth T. Waters, Vertol Aircraft Corp., Morton
Lucien Nelson, Philco Corp., 4700 Wissahickon Ave., Philadelphia 44
William W. Rosborough, Tele-Dynamics Inc., 5000 Parkside Ave., Philadelphia

*Tennessee*

William B. Reis, Sperry Farragut Co., Bristol

*Texas*

Loren H. Vaughan, Jr., Temco Aircraft, Garland
James O. Reece (Texas Instruments Inc.), 700 Hyde Park, Richardson
Robert E. Englehardt, Southwest Research Institute, 8500 Culebra Road, San Antonio
Carl A. Hafer, Southwest Research Institute, 8500 Culebra Road, San Antonio

*Vermont*

Robert G. Chadwock (G. E. Co.), 12 Wealthy Ave., S. Burlington

**COMPANY MEMBERS**

Parameters Inc., 195 Herricks Road, New Hyde Park, N. Y.
Permanent Representatives: Roger J. Amorosi—Albert F. Tramposch—John R. Crawford
Rotating Representatives: George L. Hirschberger—Frederick D. Reimer

**GOVERNMENT AGENCIES**

U. S. Naval Ordnance Laboratory, Code 56, Corona, Cal.
Rep: Herwil M. Bryant
Naval Ordnance Experimental Unit, 9900 Georgia Ave., Silver Spring, Maryland
Rep: Theodore W. Johnson, Jr.
Office of Ordnance Research, U. S. Army Ordnance Corp., Box CM, Duke Station, Durham, N. C.
Rep: Park W. Espenchade

## HEAT TRANSFER (*Continued from Page 22*)

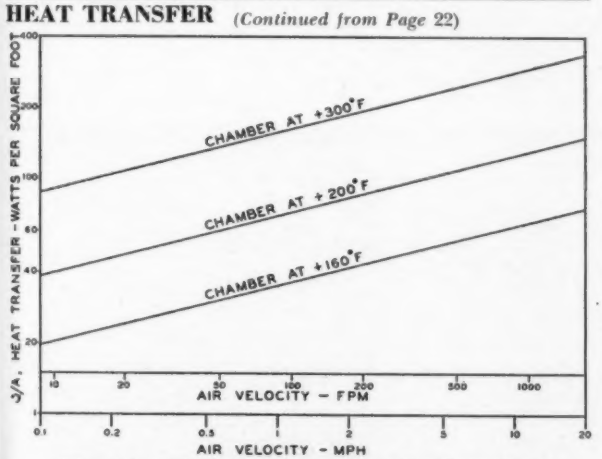

CHAMBER AT +300°F
CHAMBER AT +200°F
CHAMBER AT +160°F
BTU/SQ. FT. - HEAT TRANSFER - WATTS PER SQUARE FOOT
AIR VELOCITY - FPM
AIR VELOCITY - MPH

**Figure 8. Heat transfer from chamber to exciter**

With the baffle used in the Diamond Ordnance Fuze Lab installation, no auxiliary heating was required. The environmental engineer should compare the costs of a temperature barrier with the cost of an auxiliary heater, remembering that not only the electrical input to the exciter, but also the heat input to the oil system, represent additional load on the refrigeration system of the chamber. With modern exciters, the temperature barrier can be a simple jacket on the exciter itself. END

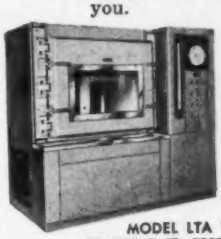

UNEQUALLED FOR ACCURACY and DEPENDABILITY

MURPHY & MILLER

TEST CHAMBERS

• ALTITUDE SIMULATION • HUMIDITY SIMULATION • LOW TEMPERATURE • HIGH TEMPERATURE

Advanced design features, highest quality materials and superior craftsmanship go into every M & M test unit to assure accurate tests and dependable operation. Before you specify or buy any test equipment—see what Murphy & Miller has to offer you.

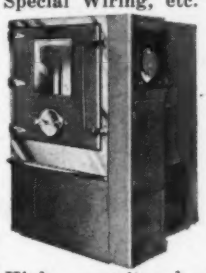


MODEL LTA 12
12 CUBIC FT. TEST SPACE

**ALTITUDE SIMULATION UNIT**

- Altitude Ranges over 200,000 ft.
- Temperature Range from +1200°F to —120°F
- Humidity cycle 20% to 95% from +35°F to 185°F
- New design—greater capacity per horsepower—lower operating cost . . . greater efficiency

Available in units with 12 to 64 cubic ft. of test space, M & M Altitude Simulation Chambers offer every standard and optional feature for faster, more flexible testing. Optional features include Program Controlled Heating, Cooling and Humidity Cycles, Automatic Recorders, Special Wiring, etc. etc.



MODEL H 12
12 CUBIC FT.
TEST SPACE

**HUMIDITY TEST CABINET**

- Provides Relative Humidities between 20% and 95%
- Temperatures from +185°F to —135°F
- Instant response of humidity system insures accurate testing
- Uniform temperature and humidity throughout test cycles

High capacity heating, refrigeration and forced air systems insure fast, accurate temperature rise and pull-down Program control cycle for temperature, humidity and cooling available. Models manufactured with test spaces to 64 cubic feet.

DRY ICE FUNGUS HUMIDITY

**NEW SLOPING FRONT UNITS**

- Exclusive sloping front for easier viewing . . . faster loading
- Available in single units or combinations

Compact, portable and inexpensive, M & M Slope Front test cabinets are made for low temperature (dry ice refrigerant) Fungus, humidity testing. Cabinets are fully automatically controlled.

**Write for illustrated literature and complete specifications.**

MURPHY & MILLER, Inc.
1322 So. Michigan Avenue Chicago 5, Illinois

6 cps to 100,000 cps at

# 1,000 WATTS CONTINUOUS DUTY

...with the new Genisco-Savage high-output amplifiers!

Here's the new line of quality, high-output amplifiers you've been waiting for. All seven models feature high power output, low distortion, exceptionally high reliability and stability, and excellent output voltage waveform.

The Model KLF, shown at left, is particularly useful as an exciter for vibration testing equipment and as a variable frequency power supply for a multitude of production and laboratory needs. It will operate *continuously* with an output of 1,000 watts from 6 to 2,000 cps.

Components of all Genisco-Savage Amplifiers are mounted on 19" vertical panels to facilitate easy inspection and maintenance. Quick-release grill covers make all tubes readily accessible from the front. Numerous built-in safety features protect the equipment from operator errors.

**Two New Shake Tables Available** The new Model V1000 Genisco-Savage Shaker features a very light moving coil assembly, high thrust-to-weight ratio, automatic impedance matching, and an excellent output waveform. A continuous alternating thrust of ±600 lbs. is produced at 1,000 watts control power. Thrust can be increased to ±750 lbs. peak by use of a blower (Model V1000B). Both models have been stress-tested to withstand continuous operation at accelerations of 100 G's.

Seven models—rugged enough for production line testing; versatile enough for almost all laboratory needs.

**The Genisco-Savage Model V1000 Shaker**

| BRIEF SPECIFICATIONS | MODELS | | | | | | |
|---|---|---|---|---|---|---|---|
| | BM2 | DM2 | KM2 | 10K | KM25 | KLF | KRF |
| Output | 250 w at 50 or 100 v | 500 w at 50 or 100 v | 1000 w at 50 or 100 v | 10,000 w maximum | 1000 w at 50 or 100 v | 1000 w at 50, 100, or 200 v | 1000 w at 25, 50 or 100 v |
| Frequency Range | 50 to 10,000 cps at 250 w | 50 to 10,000 cps at 500 w | 50 to 10,000 cps at 1000 w | 40 to 10,000 cps at 10,000 w | 50 to 10,000 cps at 1000 w | 6 to 2000 cps at 1000 w | 5 to 100 kc at 1000 w |
| Sensitivity | 0.036 v at 600 ohms | 0.04 v at 600 ohms | 0.1 v at 600 ohms | 0.16 v rms at 600 ohms for 10,000 w output | 0.1 v at 600 ohms | 0.05 v at 600 ohms | 0.5 v at 600 ohms |
| Distortion | 1% at 250 w, 1000 cps | 0.75% at 500 w, 1000 cps | Less than 0.75% at 1 kw, 1000 cps | Less than 3% at 10 kw, 1000 cps | Less than 0.75% at 1 kw, 1000 cps | Less than 5% at 1 kw, 10 to 1000 cps | |

*Price and delivery of both amplifiers and shakers are exceptionally good. For complete specifications and prices send for the new four-page illustrated brochure.*

Genisco Savage

**Genisco, Incorporated**
2233 Federal Avenue
Los Angeles 64, California

# *IEE* Second Annual Meeting Pronounced Success by Amorosi

The Institute of Environmental Engineers carried out its Second Annual Meeting with flying colors, according to Roger J. Amorosi, the society's new President, and President of Parameters, Inc. Attendance was well over the 500 mark in spite of the recession and in the face of curtailed travelling expenses on the part of many companies.

One reflection of the success of the meeting was the fact that the *New York Times,* for Sat., April 19, carried nearly a column-long story on page three about the meeting, focusing its attention on the remarks of the luncheon speaker on April 18. The speaker was Kurt R. Stehling, Propulsion Head, Project Vanguard. Stehling is shown in the lower photograph, where a model of the orbiting Vanguard satellite can be seen with him.

"I talked with a great many people," Amorosi also said, "and sentiment was uniformly to the effect that the program was of highest quality. The IEE owes a great debt to Arthur Billet for having done such an outstanding job as Program Chairman."

Billet is Vice-President of the IEE in charge of Fiscal Affairs, and is Senior Staff Engineer, Aero Hydraulics Div., Vickers Incorporated.

### 1959 Meeting Planned

The 1959 meeting, scheduled for April, in Chicago, is already well under way, Amorosi said, with Billet as General Chairman and Raymond Yaeger, Chrysler Missiles Division, as Program Chairman. Henry F. Sander, Director of Std and Quality Controls, Vapor Heating Corp., and former president of IEE, is Chairman of Facilities and Finances. Ray H. Mattingley, Editor of the *Environmental Quarterly,* is again Publicity Chairman. Other members of the Program Committee to date are: Stephen Danko, Motorola, Inc.; Robert Stallard, The Martin Company (Denver); Dick Hahn, U. S. Testing Company; and Norman Meyers, Lockheed Aircraft Corporation.

*Yaeger already is now seeking papers and urges anyone interested in presenting a paper to get in touch with him immediately.*

# Performance at table counts most in vibration testing

**E. G. ORAVEC**

Member Institute of Environmental Engineers
Chief Sales Engineer,
MB Manufacturing Company


No matter how big the equipment, what you buy in a vibration test system is really the **performance at the shaker** (able. That's the payoff.

What does it take to deliver the required performance? First of all, good design and operating characteristics in the shaker itself. Maximum mass of vibrating should be in the table, not in driver coil. Why? For maximum load carrying capacity to extreme range of shaker operating frequency. Table flexure design should permit long stroke with linear spring rate. Why? To insure undistorted sinusoidal motion at low frequencies.

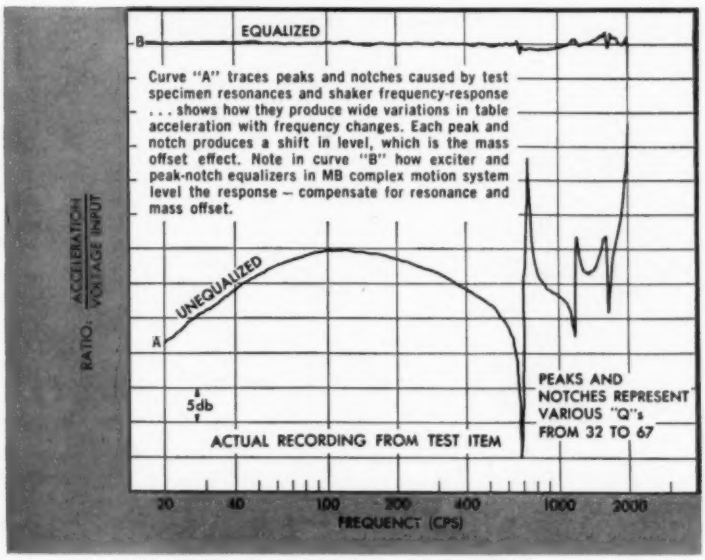
Next comes the power amplifier. It must match the needs of the shaker. Low distortion: ample usable power (continuous KVA output and KW plate dissipation rating tells more than KW output into a resistive load for driving a shaker); ability to handle the most adverse reactive shaker loads — these are some of the attributes of an MB-built matched amplifier.

Consider next the controls. Equipment design engineers familiar with vibration testing put all operating adjustments and controls within convenient reach of the operator. Sine wave testing to any specification should be provided equalization for both mass-offset and high Q.

All things considered, it's to the advantage of the environmental test engineer to get single responsibility for performance. Nobody knows better how to get optium results than the manufacturer of the **complete** system. MB is such a source—the **only** one.

***In MB Shaker Systems...***

# response equalized for "hi-fi" random motion


EQUALIZED
B
Curve "A" traces peaks and notches caused by test specimen resonances and shaker frequency-response . . . shows how they produce wide variations in table acceleration with frequency changes. Each peak and notch produces a shift in level, which is the mass offset effect. Note in curve "B" how exciter and peak-notch equalizers in MB complex motion system level the response – compensate for resonance and mass offset.
RATIO: ACCELERATION / VOLTAGE INPUT
UNEQUALIZED
A
5db
PEAKS AND NOTCHES REPRESENT VARIOUS "Q"s FROM 32 TO 67
ACTUAL RECORDING FROM TEST ITEM
20
40
100
200
400
1000
2000
FREQUENCY (CPS)

For accurate reproduction of vibration environments, the variation of shaker table acceleration with time should be identical to that of the input voltage. Flat frequency response of the system insures this result.

**ADVANTAGES OF MB SYSTEM**

With electronic analogs, MB's peak-notch compensator gives the exact inverse electrical equivalence of the mechanical system resonance. Independent adjustment of the peak and notch frequencies allows peak to occur prior to notch, (or vice versa), in a single unit as required by the specimen. This automatically, precisely provides the mass offset required. Compensator also corrects for high Q resonances at low as well as high frequencies.

MB is the only manufacturer of all units comprising complete random motion test systems. Avail yourself of our experience, quality design, and technical service facilities. Send for Bulletin 420E that tells more.

***MB manufacturing company***

**A DIVISION OF TEXTRON INC.**

**1057 State Street, New Haven 11, Connecticut**

HEADQUARTERS FOR PRODUCTS TO ISOLATE . . . EXCITE . . . AND MEASURE VIBRATION

# ENVIRONMENTAL TESTING

## *Plus . . .*

**. . . Allied engineering services for the complete job — which may also involve electrical, electronic, physical, and chemical measurements and determinations — required by Military and your specifications.**

**ETL is a completely independent organization, with a background of nearly 60 years of *Testing for Industry.***

Over 65,000 sq. ft. of our well equipped laboratory is devoted exclusively to testing services for Industry.

To help you and your management explore the possibilities for relief from your engineering problems, ETL has just prepared a listing of services and facilities. It is yours for the asking.

*Know by* ETL *Test*

**ELECTRICAL TESTING LABORATORIES, INC.**

*2 East End Avenue at 79th Street • New York 21, N. Y. • BUtterfield 8-2600*

CHEMICAL • ELECTRICAL • ELECTRONIC
PHYSICAL • MECHANICAL • ENVIRONMENTAL

TESTING • INSPECTION
CERTIFICATION

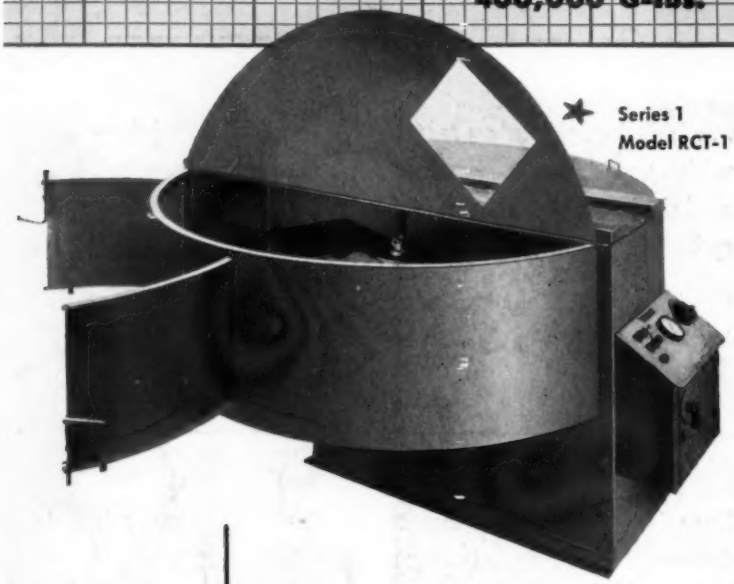
INCLUDING INFRARED SPECTROSCOPY, PHOTOMETRY, RADIOMETRY, SPECTROPHOTOMETRY AND PHOTOMICROGRAPHY

**Environmental**

# TEST LOADINGS OF MISSILE COMPONENTS and ASSEMBLIES

**...up to: 150 G 8,000 lbs. 400,000 G-lbs.**

**other RUCKER PRECISION EQUIPMENT**



★ Series 1 Model RCT-1

**FULL RANGE of 8 MODELS AVAILABLE**

**SERIES 1**
G-rating: 1 to 150
Test radius: 18" to 46"
Specimen: 30-100 lbs.

**SERIES 10**
G-rating: 1 to 150
Test radius: 96" to 240"
Specimen: 300-600 lbs.

**SERIES 20**
G-rating: 1 to 100
Test radius: 264" to 420"
Specimen: 2000-8000 lbs.

**FOR FAST, ACCURATE TESTING** – as required by MIL-E-5272A.

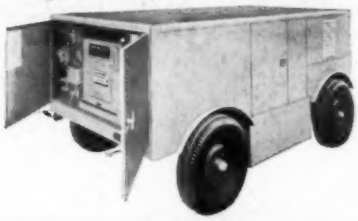
Rucker Centrifuge Acceleration Test Machines in a full range of sizes are precision-engineered for accurate pre-testing of components, instruments and assemblies employed in aircraft, missiles and rockets under simulated operational acceleration loadings in the 1 to 150 G-range. They are ideally suited both for exacting laboratory testing and mass production-line testing procedures.

*Write for full details, today.*
*State your range of requirements.*

**RUCKER Centrifuge**
**ACCELERATION TEST MACHINES**

The Rucker Company, 4706 San Pablo Avenue, Oakland, California

- **HI-PRESSURE GAS BOOSTERS**



Stationary or portable high pressure gas boosters for compressing helium or nitrogen up to 6000-10,000 p.s.i. for missile development and production testing or flight line checkout.

- **TEST BENCHES**

Standard or custom designed stationary or portable test benches for precision testing of all types of hydraulic or pneumatic components and systems.

★ **Series 20 Model RCT-21**

View of 22′ radius arm and powerhead installed in test pit. This large Series 20 unit is designed for testing 4,000 lb. specimen at 100 G-rating.